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1983 DIRECT STRIKE LIGHTNING DATA

Mitchel E. Thomas

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* Part 2 and Part 3 published under separate cover.

1983 DIRECT STRIKE LIGHTNING DATA

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SUMMARY

This report presents the wideband waveforms recorded during the 1983 Direct-Strike Lightning Tests of the NASA Langley Research Center lightning-instrumented F-106B aircraft. The tests were conducted within about 150 nautical miles of the NASA Langley Research Center, Hampton, Virginia, where the aircraft was based. The entire transient recorder data obtained for 214 strikes and 112 nearby flashes in the 1983 campaign are presented in this report.

SYMBOLS

B	magnetic flux density, tesla
D	electric flux density, coulomb per square meter
I	current, ampere
A/m^2	ampere per square meter
m	meter
MHz	megahertz
T/s	tesla per second
A	ampere
A/s	ampere per second
V	volt

SUBSCRIPTS:

F	forward fuselage
L	longitudinal
N	nose
T	tail (or transverse, when associated with B)
W	wing
WL	wing-left
WR	wing-right

Rate of change of a quantity is indicated by a dot over the symbol in the text, and symbols are written on computer plots of the waveforms-e.g., \dot{B}_L is written B DOT L.

INTRODUCTION

This report presents the wideband direct-strike lightning data obtained from the digital transient recorders during the 1983 Lightning Flight Tests of the NASA Langley Research Center lightning-instrumented F-106B aircraft. There were 214 strikes to the aircraft during this campaign; there were 10 strikes in each of the 1980 and 1981 tests which were reported in references 1 and 2, and 156 strikes in 1982 which were reported in reference 3. The instrumentation system, transient recorders, sensors, and a summary overview of the previous tests are presented in references 4, 5, 6, and 7, respectively.

DATA SYSTEMS

The first data flights of the 1983 season were conducted with a two-channel expanded Biomation transient recorder system described in references 4 and 5. On August 7, 1983, this system was replaced by a twelve-channel system, developed by LeCroy Research Systems Corporation, having the following major features: 8-bit resolution (6-bit resolution with previous system), 10 nanosecond sampling interval (same as previous system), 65536 sample capacity per channel (half the capacity of previous system), and simultaneous recording on all channels (not possible with previous system). There were some problems resulting from the inability of the new recorders to meet performance specifications in the aircraft flight environment and the remaining data flights (83-044 to 83-054) were made with no less than 4 and no more than 9 channels operational.

The Boeing Company developed data logger described in reference 8 was used to acquire transient data on the F-106 aircraft in 1983. A six-channel system was configured for approximately 12,000 sample capacity per channel and 16 2/3 nanosecond sampling intervals.

1983 LIGHTNING DATA

The 1983 tests resulted in 214 direct strikes to the aircraft and 112 nearby flashes from storm penetration flights at flight levels generally above 20,000 feet. Table 1 summarizes, by flight number, the 1983 data records acquired with the two-channel transient recorder system and the data logger. Sensor locations on the aircraft are shown in figure 1. The sensor at location 2 measures the rate-of-change of electric flux density, \dot{D}_F (labeled D DOT FWD on the waveform plots), and the sensor at location 6 measures the rate-of-change of magnetic flux density, \dot{B}_L (labeled B-DOT L on the waveform plots). The sensor at location 1 measures current in the pitot boom (labeled I_N on waveform plots) and the sensor at location 13 measures current in the fin-cap on the vertical tail (labeled I_T on the waveform plots). The voltage induced in an insulated wire routed through the aircraft from forward fuselage (between locations 1 and 2) to the instrumentation package (approximately mid-aircraft) is measured across 50 ohms and is labeled V_F on the waveform plots. In table 1, the entries under \dot{D}_F and \dot{B}_L are the run numbers which identify each 1310 microsecond record acquired during strikes and nearby strikes from the \dot{D}_F and \dot{B}_L sensors at 10-nanosecond sample intervals, and under I_N , I_T , and V_F are the run numbers which identify each 205 microsecond record acquired from the I_N , I_T , and internal wire voltage, V_F , sensors at 16 2/3 nanosecond sample intervals. Tables 2 and 3 summarize, by flight number, the remaining

1983 data records acquired with the new twelve-channel transient recorder and the data logger. The entries under the various sensor headings are the run numbers of each 655 microsecond record acquired with the transient recorder system and each 205 microsecond record acquired with the data logger. The additional sensor locations are shown in figure 1 and the following labels identify the waveform plots: \dot{B}_{WL} is a rate of change of magnetic flux density measurement at location 8; \dot{B}_{WR} is a rate of change of magnetic flux density measurement at location 10; \dot{D}_{WL} is a rate of change of electric flux density measurement at location 9; \dot{D}_{WR} is a rate of change of electric flux density measurement at location 11; \dot{D}_T is a rate of change of electric flux density measurement at location 12; \dot{B}_T is a rate of change of magnetic flux density measurement at location 7; \dot{I} is a rate of change of current measurement at location 1; and V_W is a voltage measurement on an insulated wire located in the leading edge of the left wing. Time histories of each record and expanded time segments of the dynamic portions of the transient recorder plots are included in this report. Labeling on each plot through flight 83-042 indicates flight number, run number, and a strike/nearby code for each recorded event which can be used to correlate this data with other data for the same event. Labeling on the plots from flight 83-044 and subsequent flights (acquired with the twelve-channel system) is different in that the flight number and run number may appear only on the first plot of the multiple plots acquired for a single event. Data logger plots are also labeled with flight number, run number, and a strike/nearby code corresponding to transient recorder plots for the same event. In cases where data logger plots are included for events which have no transient recorder plots, and consequently no run number, the data logger plot is labeled RUN X. The only correlation to other supporting data is through time of occurrence which is shown on the

plot. The sign conventions established for the measurements shown in figure 1 indicate positive quantities in the direction of the arrows; the relation between the sign conventions of the variables D , B , and I and their derivatives are shown in the measurement polarity time history also in figure 1.

The system's two transient recorders were connected to \dot{D}_F and \dot{B}_L sensors for flights 83-011 through 83-042. Both recorders were triggered from \dot{D}_F through flight 83-016 and from \dot{B}_L for flights 83-017 through 83-042. The twelve-channel transient recorder system, installed for flights 83-044 through 83-055, used \dot{D}_F to trigger all channels for all flights. Measurement ranges and thresholds for the various system configurations are shown in table 4. The six-channel data logger system was connected to I_N (high and low sensitivity), I_T (high and low sensitivity), \dot{B}_T (high and low sensitivity), V_F , and V_W selectively throughout the 1983 season. Measurement ranges and thresholds for the various data logger configurations are shown in table 5.

Occasional discontinuities appear in the recorded waveforms. These are the result of an error in the transient recorder analog-to-digital conversion hardware at sampling time, or an error in storing the sample in the recorder solid state memory. These discontinuities are usually easy to identify in the waveform because of the sudden transition to either a positive or negative maximum of the recorder dynamic range in one or two samples. These discontinuities do not appear in the expanded plots of the data with the exception of the plots of \dot{D}_F from flight 83-013, runs 12 and 14. A perturbation to the data which is unique to the twelve-channel transient recorders is a "stair-step" discontinuity which is caused by the analog-to-digital conversion hardware in the recorder. This small error was corrected and is most apparent in the expanded \dot{D}_F waveforms for the early flights with this system (83-044, 83-045, 83-046).

Two battery powered peak-level recorders were used on the aircraft in 1983 to continuously monitor and record the maximum amplitude achieved by the \dot{D}_F and \dot{I} measurements for each flight (the results are shown in table 6). The maximum rate of change of current recorded from the \dot{I} sensor was 1.9×10^{11} A/s and occurred on Flight 83-045, and the largest peak level recorded for \dot{D}_F was 36 A/m^2 on flight 83-030, although there were several "over-scales" ($>49 \text{ A/m}^2$) indicated for \dot{D}_F throughout the season.

CONCLUSION

The waveforms recorded in 1983 are comparable to those recorded in previous years on this aircraft. A formal analysis of the data is not complete at the time of this report, but a cursory review of the data finds amplitudes and temporal features of \dot{D}_F , \dot{B}_L , \dot{I} , and I waveforms to be very much like those reported for 1982 in reference 3. The data from flight 83-044 and subsequent flights is significant because, for the first time, simultaneous, time correlated electromagnetic measurements from more than two points on the surface of the aircraft are available with 10 nanosecond time resolution.

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TABLE 1. 1983 DATA SUMMARY FOR FLIGHTS 83-011 through 83-042

<u>DATE</u>	<u>FLIGHT NUMBER</u>	<u>NUMBER STRIKES</u>	<u>NUMBER NEARBY</u>	\dot{D}_F	\dot{B}_L	<u>RUN NUMBERS</u> \underline{I}_T	\underline{V}_F	\underline{I}_N
5/20	83-011	1	0	2	2			
5/21	83-012	0	1	1(a)				
5/23	83-013	18	1	1,2(a),4, 6,7,9,10, 12 thru 14	1 thru 14			
5/26	83-015	3	0	1,2	1,2			
5/26	83-016	0	4	1,2,4	1 thru 4			
6/06	83-017	1	0	1(a)				
6/06	83-018	1						X(c)(b)
6/15	83-019	0	2		1,2			
6/16	83-020	3	3	1,2,6	1 thru 6	1,5(b)		
6/17	83-021	3	0	3	2,3	2(b)		
6/17	83-022	1	1	2	2,3			
6/18	83-023	1	0	1	1	1(b)		
6/18	83-024	5	2	1,2,3(a), 4,5	1 thru 5	5(b)		
6/28	83-025	4	6	4,5,6,8	7,8,9	5,6,X, (c)(b)		
6/28	83-026	0	1		A1			
7/01	83-028	1	3	1,2	1 thru 3			
7/01	83-029	16	15	1,3,4,7,9, 12(a),13, 17,19,20, 21(a)	1 thru 28	3,17,X, 24,X,		
7/05	83-030	14	7	1 thru 6, 8 thru 10, 12,13, 15 thru 17	1 thru 17	3,8,X, (c)(b)		
7/18	83-031	1	0					
7/19	83-032	8	7	3 thru 6, 8 thru 10 11(a),12	1 thru 12			
7/19	83-033	12	7	1,6 thru 8, 11 thru 13, 15,16	1 thru 16			
7/20	83-035	1	2		1(a),2,3			
7/22	83-036	20	22	2,3, 5 thru 10, 12(a),14,15, 20 thru 23, 25,33,34, 36,37	1 thru 24 26 thru 37			
7/22	83-037	11	6	1 thru 3, 5 thru 7, 9 thru 11	1 thru 14			
8/06	83-042	1	3		1 thru 4	2(b)	2(b)	

(a) Low amplitude expanded waveforms not included

(b) Recorded on Boeing data logger

(c) Data logger record not corresponding to transient recorder run number is labeled X

TABLE 2. 1983 DATA SUMMARY FOR FLIGHTS 83-044 through 83-054 (transient recorder)

<u>DATE</u>	<u>FLIGHT NUMBER</u>	<u>NUM STKS</u>	<u>NUM NRBY</u>	RUN NUMBERS							
				\dot{D}_F	\dot{B}_L	\dot{B}_{WR}	\dot{D}_T	\dot{I}	\dot{B}_{WL}	\dot{D}_{WL}	\dot{B}_T
8/07	83-044	12	2	1-11	-	1-11	1-8, 10,11	1-8, 10,11	-	-	-
8/09	83-045	9	7	1-9	-	1-9	1, 3-6, 8,9	1, 3-6, 8,9	-	-	-
8/09	83-046	8	1	1-5	-	1-5	1-5	1-5	-	-	-
8/22	83-048	8	2	1, 2(a), 4,7,8	-	1, 2(a), 3-7, 8(a)	1	1	1, 2(a), 3-7, 8(a)	1, 2(a), 4,7,8	1, 2(a), 3-7, 8(a)
8/23	83-049	3	0	1(a)	1(a)	1(a)	1(a)	1(a)	1(a)	1(a)	1(a)
8/23	83-050	40	1	1-3, 5,10, 12	1-4, 5(a), 6,7, 9,10, 11(a), 12-14	1-7, 9,10, 11(a), 12-14	1-4, 5(a), 6,7, 9,10, 11(a), 12-14	1-4, 5(a), 6,7, 9,10, 11(a), 12-14	1-7, 9,10, 11(a), 12-14	1-5, 10,12	1-7, 9,10, 11(a), 12-14
9/01	83-051	1	0	-	-	-	-	-	-	-	-
9/12	83-052	0	1	-	2	-	2	2	2	2	-
9/12	83-053	2	1	-	1,2	-	1,2	1,2	1,2	1,2	-
9/13	83-054	5	4	1-8	1-8	-	1-8	1-8	-	1-8	-

(a) Low amplitude expanded waveforms not included

TABLE 3. 1983 DATA SUMMARY FOR FLIGHTS 83-044 through 83-054 (DATA LOGGER)

<u>DATE</u>	<u>FLIGHT NUMBER</u>	<u>NUMBER STRIKES</u>	<u>NUMBER NEARBY</u>	RUN NUMBERS(a)			
				<u>I</u> <u>-N</u>	<u>I</u> <u>-T</u>	<u>V</u> <u>-F</u>	<u>V</u> <u>-W</u>
8/07	83-044	12	2	-	X,3, 5,X	X,3, 5,X	X,X
8/09	83-045	9	7	8	1,3,8, X,X	1,3,8, X	X,X,X
8/09	83-046	8	1	-	X,4	-	X,X
8/22	83-048	8	2	2,X, 7,X	2,X, 7,X	2,X, 7,X	-
8/23	83-049	3	0	1,X	1,X	1,X	1
8/23	83-050	40	1	2,X, X,7, X	2,X, X,7	2,X, X,7, X,X	-
9/01	83-051	1	0	-	-	-	-
9/12	83-052	0	1	-	-	-	-
9/12	83-053	2	1	-	-	-	-
9/13	83-054	5	4	2,4	2,4	2,4	-

(a) Data logger record not corresponding to transient recorder run number is labeled X

TABLE 4. 1983 LIGHTNING MEASUREMENT RANGES-TRANSIENT RECORDERS

<u>FLIGHT NO.</u>	<u>SENSOR</u>	<u>FULL SCALE</u>	<u>THRESHOLD</u>
83-011 to 83-016	\dot{D}_F \dot{B}_L	$+19 \text{ A/m}^2$ $+1000 \text{ T/s}$	-2.9 A/m^2 * triggered by \dot{D}_F
83-017 to 83-042	\dot{B}_L \dot{D}_F	$+1500 \text{ T/s}$ $+19 \text{ A/m}^2$	-220 T/s * triggered by \dot{B}_L
83-044 to 83-046	\dot{D}_F \dot{B}_{WR} \dot{D}_T \dot{I}	$+10 \text{ A/m}^2$ $+4700 \text{ T/s}$ $+10 \text{ A/m}^2$ $+2.4 \times 10^{11} \text{ A/s}$	$+2.9 \text{ A/m}^2$ * triggered by \dot{D}_F * triggered by \dot{D}_F * triggered by \dot{D}_F
83-048 to 83-051	\dot{D}_F \dot{D}_{WL} \dot{D}_T \dot{B}_L \dot{B}_{WL} \dot{B}_{WR} \dot{D}_T \dot{I}	$+10 \text{ A/m}^2$ $+19 \text{ A/m}^2$ $+10 \text{ A/m}^2$ $+1800 \text{ T/s}$ $+930 \text{ T/s}$ $+930 \text{ T/s}$ $+900 \text{ T/s}$ $+2.4 \times 10^{11} \text{ A/s}$	$+2.9 \text{ A/m}^2$ * triggered by \dot{D}_F * triggered by \dot{D}_F * triggered by \dot{D}_F * triggered by \dot{D}_F * triggered by \dot{D}_F * triggered by \dot{D}_F * triggered by \dot{D}_F
83-052 to 83-055	\dot{D}_F \dot{D}_{WL} \dot{D}_T \dot{B}_L \dot{B}_{WL} \dot{I}	$+10 \text{ A/m}^2$ $+19 \text{ A/m}^2$ $+10 \text{ A/m}^2$ $+1800 \text{ T/s}$ $+930 \text{ T/s}$ $+2.4 \times 10^{11} \text{ A/s}$	$+2.9 \text{ A/m}^2$ * triggered by \dot{D}_F * triggered by \dot{D}_F * triggered by \dot{D}_F * triggered by \dot{D}_F * triggered by \dot{D}_F

TABLE 5. 1983 LIGHTNING MEASUREMENT RANGES-DATA LOGGER

<u>FLIGHT NO.</u>	<u>SENSOR</u>	<u>FULL SCALE</u>	<u>THRESHOLD</u>
83-011 to 83-031	I _N	+50000 A	+20000 A
	I _N	+20000 A	+8000 A
	B _T	+44000 T/s	* triggered by I _N
	B _T	+18000 T/s	* triggered by I _N
	I _T	+1000 A	+400 A
	I _T	+400 A	+160 A
	I _T		
83-042 to 83-046	I _N	+50000 A	+10000 A
	I _T	+2000 A	* triggered by I _N
	V _W	+1 V	* triggered by I _N
	V _W	+1 V	* triggered by I _T
	I _F	+20000 A	* triggered by I _T
	I _N	+400 A	+80 A
	I _T		
83-048 to 83-050	I _N	+13000 A	+2500 A
	I _T	+50000 A	* triggered by I _N
	V _W	+3.2 V	* triggered by I _N
	V _W	+7.5 V	* triggered by I _T
	I _F	+5000 A	* triggered by I _T
	I _N	+10000 A	+2000 A
	I _T		
83-051 to 83-055	I _N	+13000 A	+2500 A
	I _T	+25000 A	* triggered by I _N
	V _W	+3.2 V	* triggered by I _N
	V _W	+15 V	* triggered by I _T
	I _F	+5000 A	* triggered by I _T
	I _N	+5000 A	+2000 A
	I _T		

TABLE 6. 1983 DATA SUMMARY-PEAK LEVELS

DATE	FLIGHT NUMBER	NUMBER STRIKES	NUMBER NEARBY	PEAK LEVEL $\frac{D}{F}$	RECORDED $\frac{I}{I}$
5/16	83-010	0	0	0	0
5/20	83-011	1	0	18 A/m ²	0
5/21	83-012	0	1	0	0
5/23	83-013	18	1	*	*
5/26	83-015	3	0	28 A/m ²	1.0E+10 A/s
5/26	83-016	0	4	17 A/m ²	0.5E+10 A/s
6/06	83-017	1	0	0	0
6/06	83-018	1	0	15 A/m ²	1.0E+10 A/s
6/15	83-019	0	2	>49 A/m ²	2.1E+10 A/s
6/16	83-020	3	3	26 A/m ²	4.4E+10 A/s
6/17	83-021	3	0	24 A/m ²	*
6/17	83-022	1	1	*	*
6/18	83-023	1	0	*	*
6/18	83-024	5	2	*	*
6/28	83-025	4	6	23 A/m ²	2.1E+10 A/s
6/28	83-026	0	1	0	0
6/30	83-027	0	0	0	0
7/01	83-028	1	3	27 A/m ²	3.9E+10 A/s
7/01	83-029	16	15	*	*
7/05	83-030	14	7	36 A/m ²	4.3E+10 A/s
7/18	83-031	0	0	6 A/m ²	0
7/19	83-032	8	7	30 A/m ²	6.7E+10 A/s
7/19	83-033	12	7	*	*
7/20	83-035	1	2	*	*
7/22	83-036	20	22	>49 A/m ²	1.3E+11 A/s
7/22	83-037	11	6	32 A/m ²	2.2E+10 A/s
8/02	83-040	0	0	0	0
8/05	83-041	0	0	0	0
8/06	83-042	1	3	15 A/m ²	6.7E+10 A/s
8/07	83-044	12	2	31 A/m ²	2.1E+10 A/s
8/09	83-045	9	7	>49 A/m ²	1.9E+11 A/s
8/09	83-046	8	1	27 A/m ²	4.3E+10 A/s
8/22	83-048	8	2	>49 A/m ²	1.2E+11 A/s
8/23	83-049	3	0	>49 A/m ²	1.5E+11 A/s
8/23	83-050	40	1	>49 A/m ²	1.2E+11 A/s
9/01	83-051	1	0	2 A/m ²	1.0E+10 A/s
9/12	83-052	0	1	17 A/m ²	6.8E+10 A/s
9/12	83-053	2	1	29 A/m ²	1.4E+10 A/s
9/13	83-054	5	4	17 A/m ²	9.9E+10 A/s
9/14	83-055	0	0	0	0

* low battery voltage resulted in no data

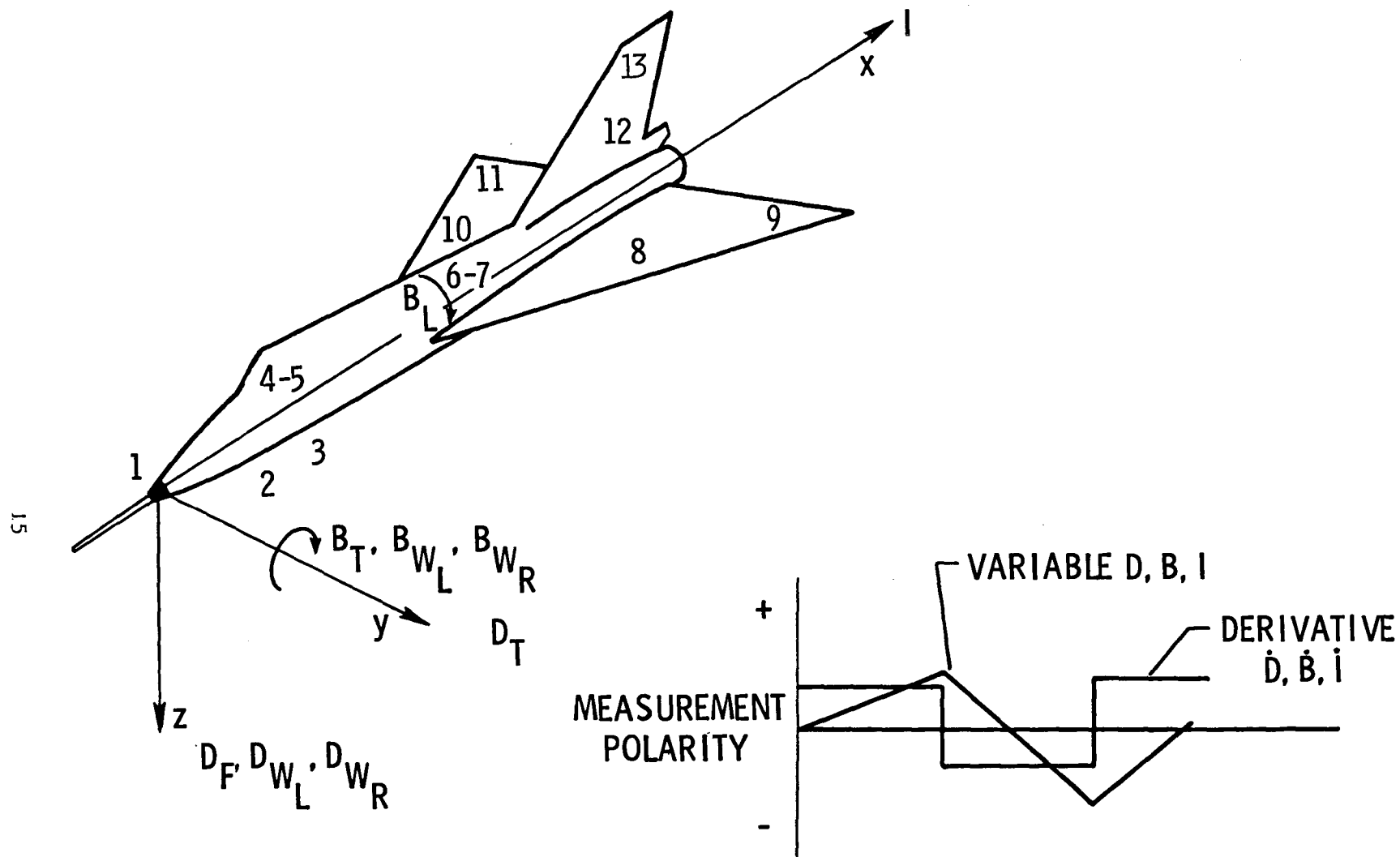


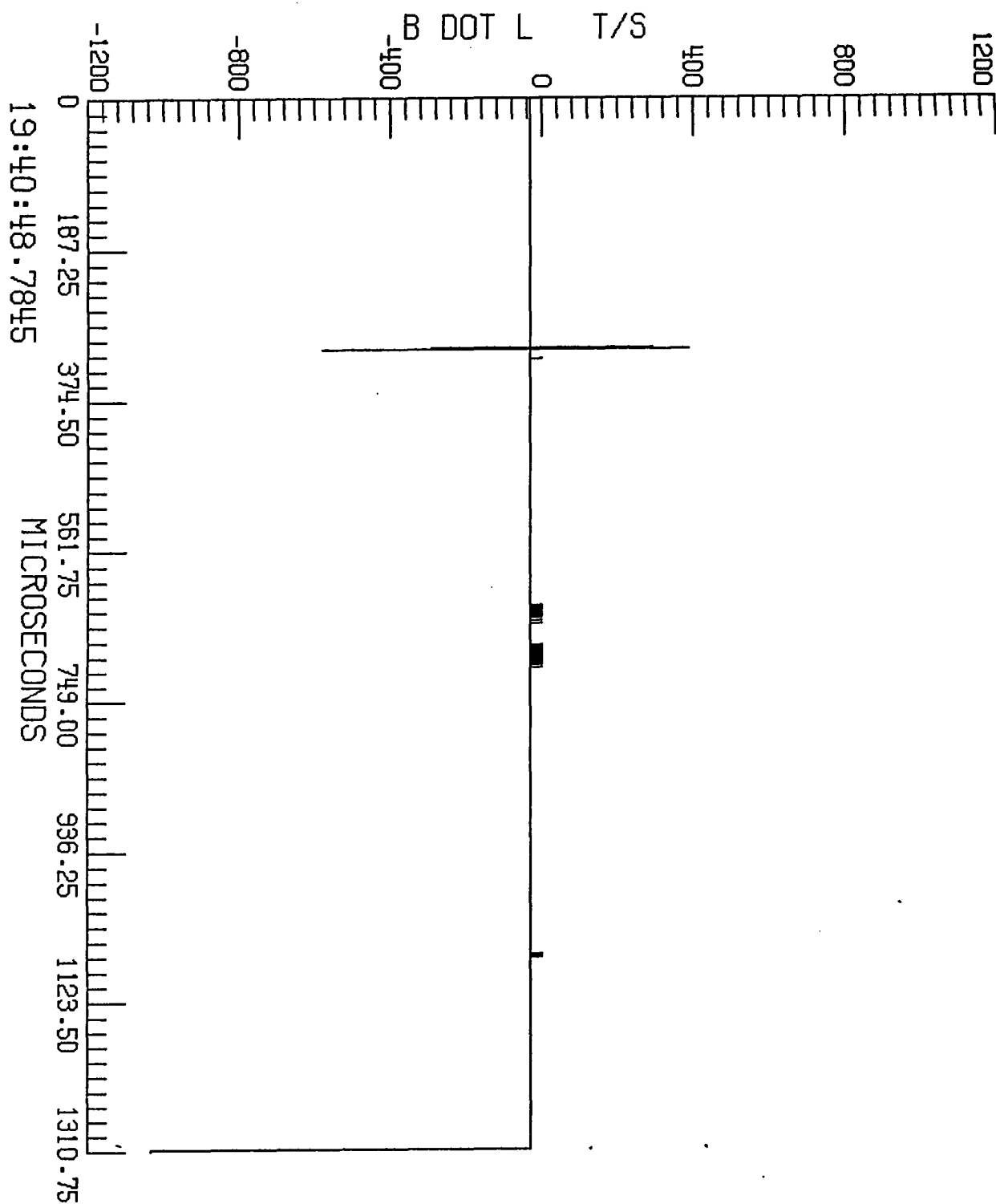
Figure 1. - Electromagnetic sign conventions and sensor locations.

F106 LIGHTNING/TK-8/83-011/THOMAS

TEST NO. 83-(

RUN NO. 2

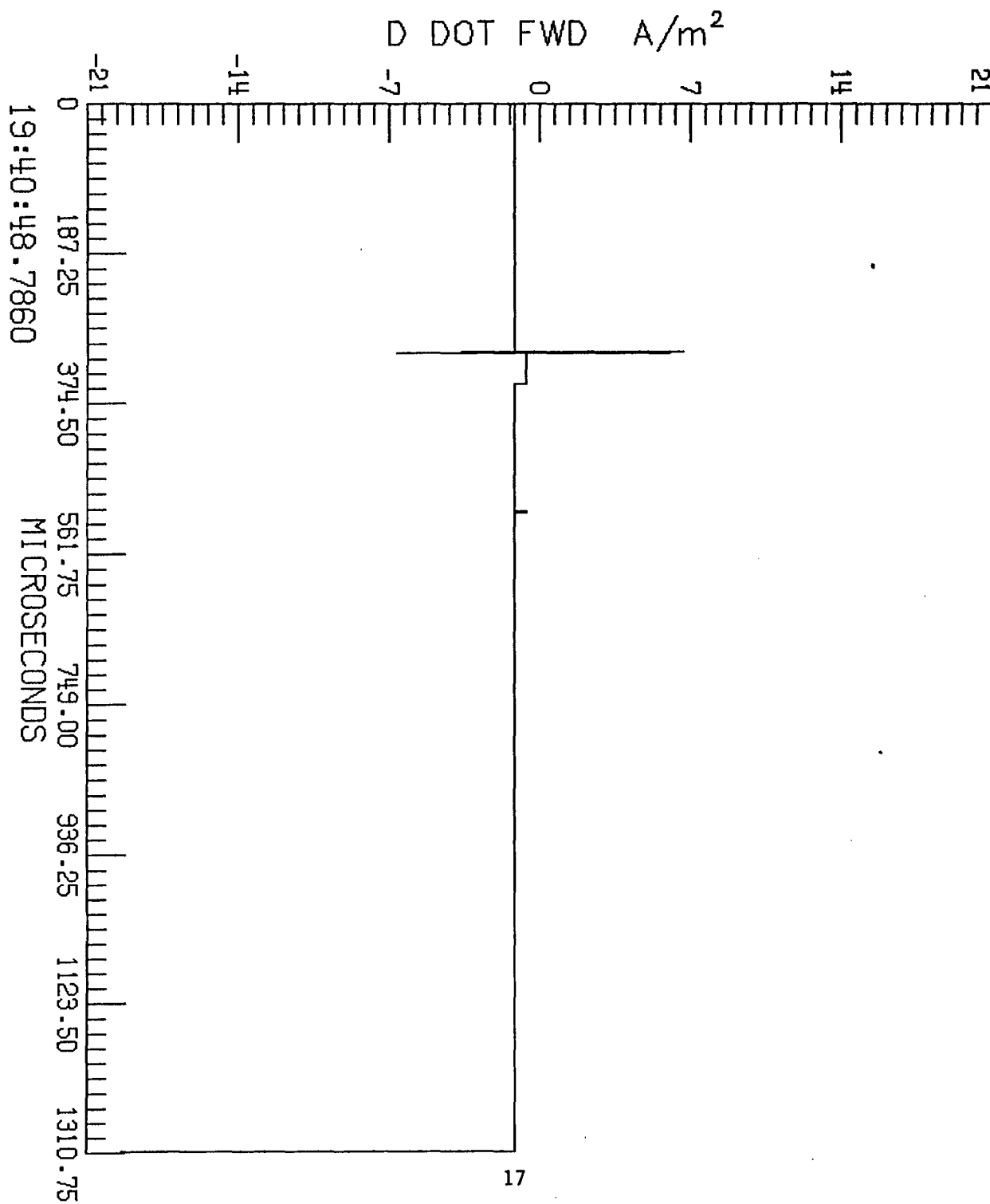
S-001



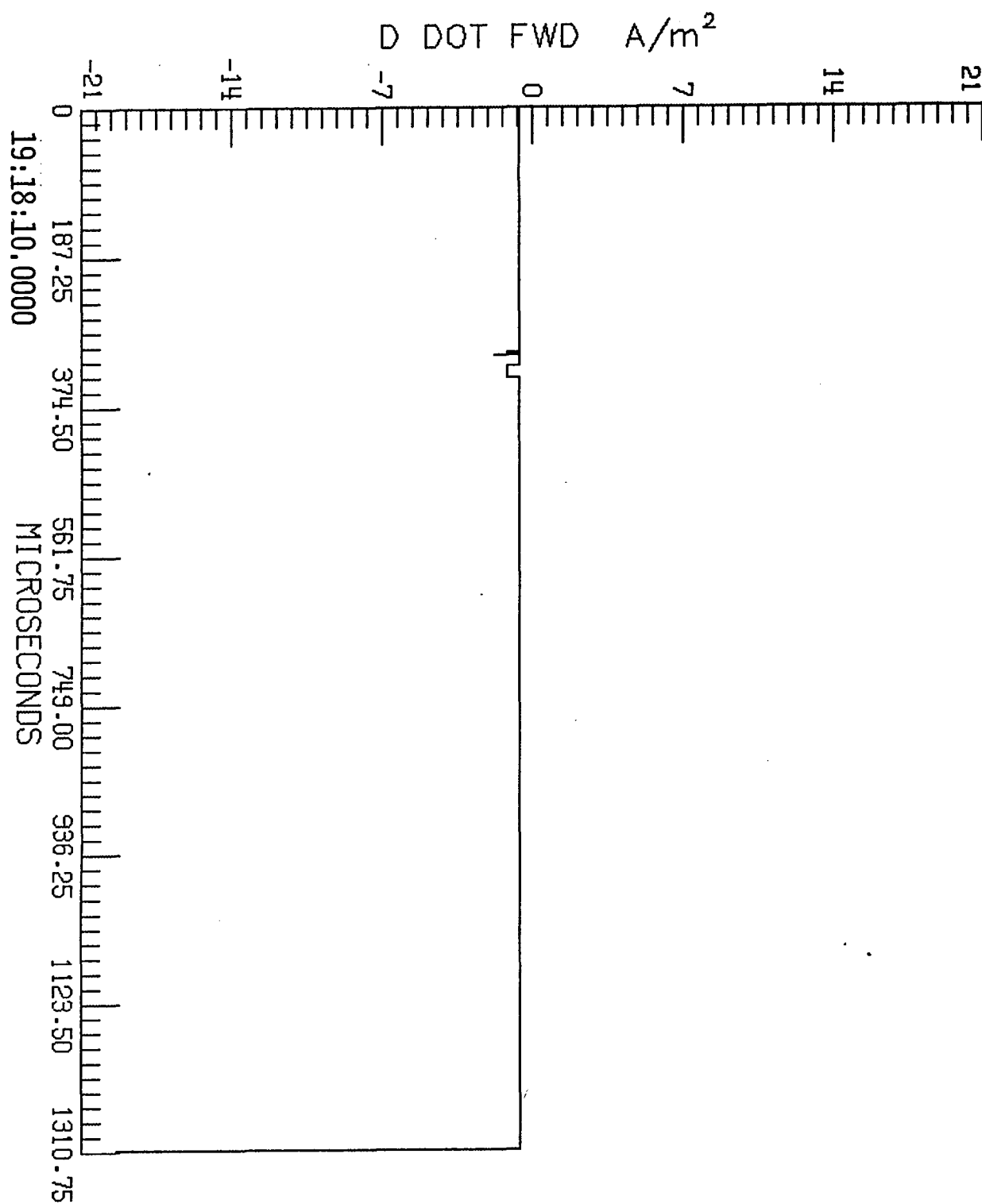
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RUN NO. 2

S-001

TEST NO. 83-(



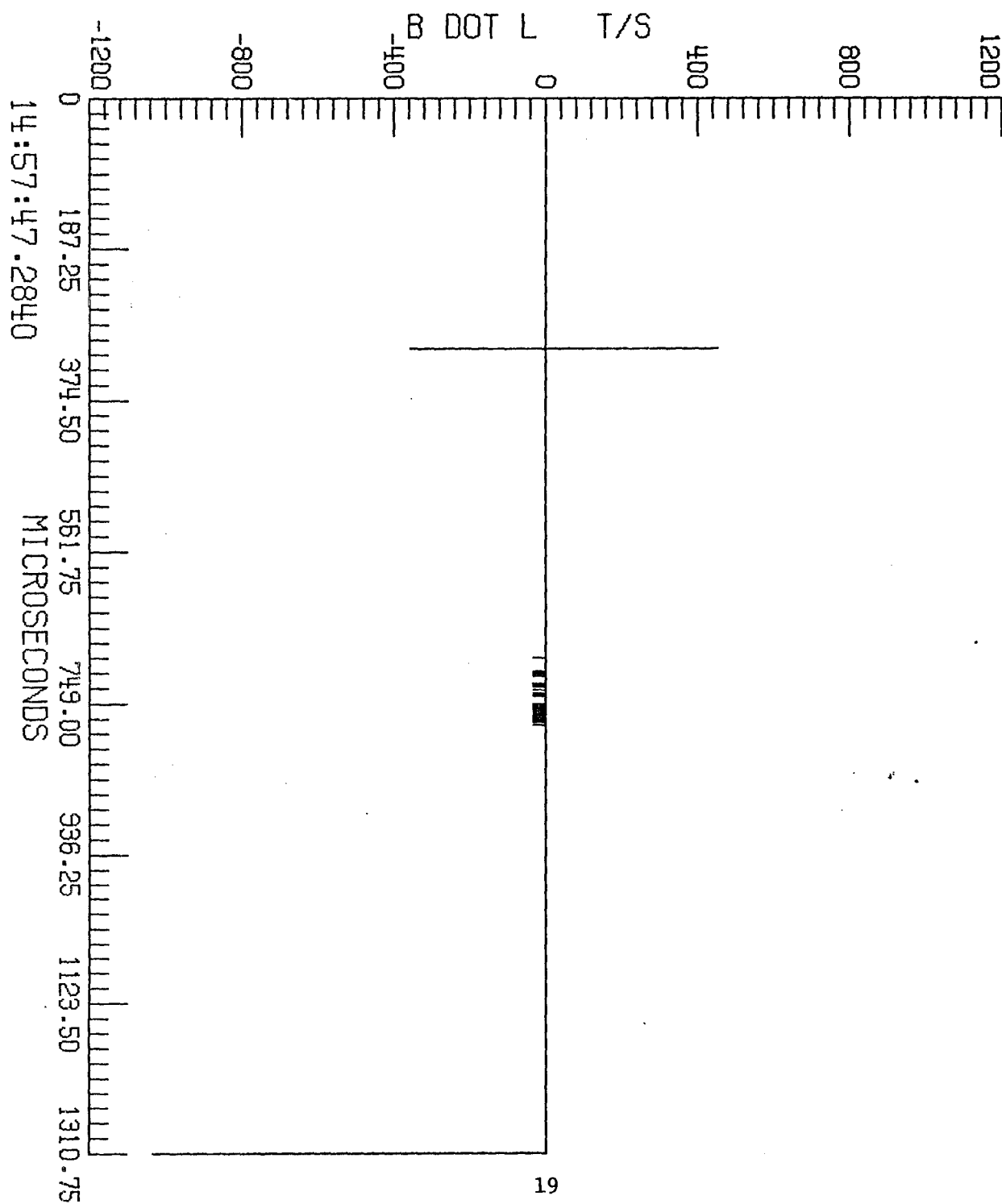
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F106 LIGHTNING/83-013/M.THOMAS

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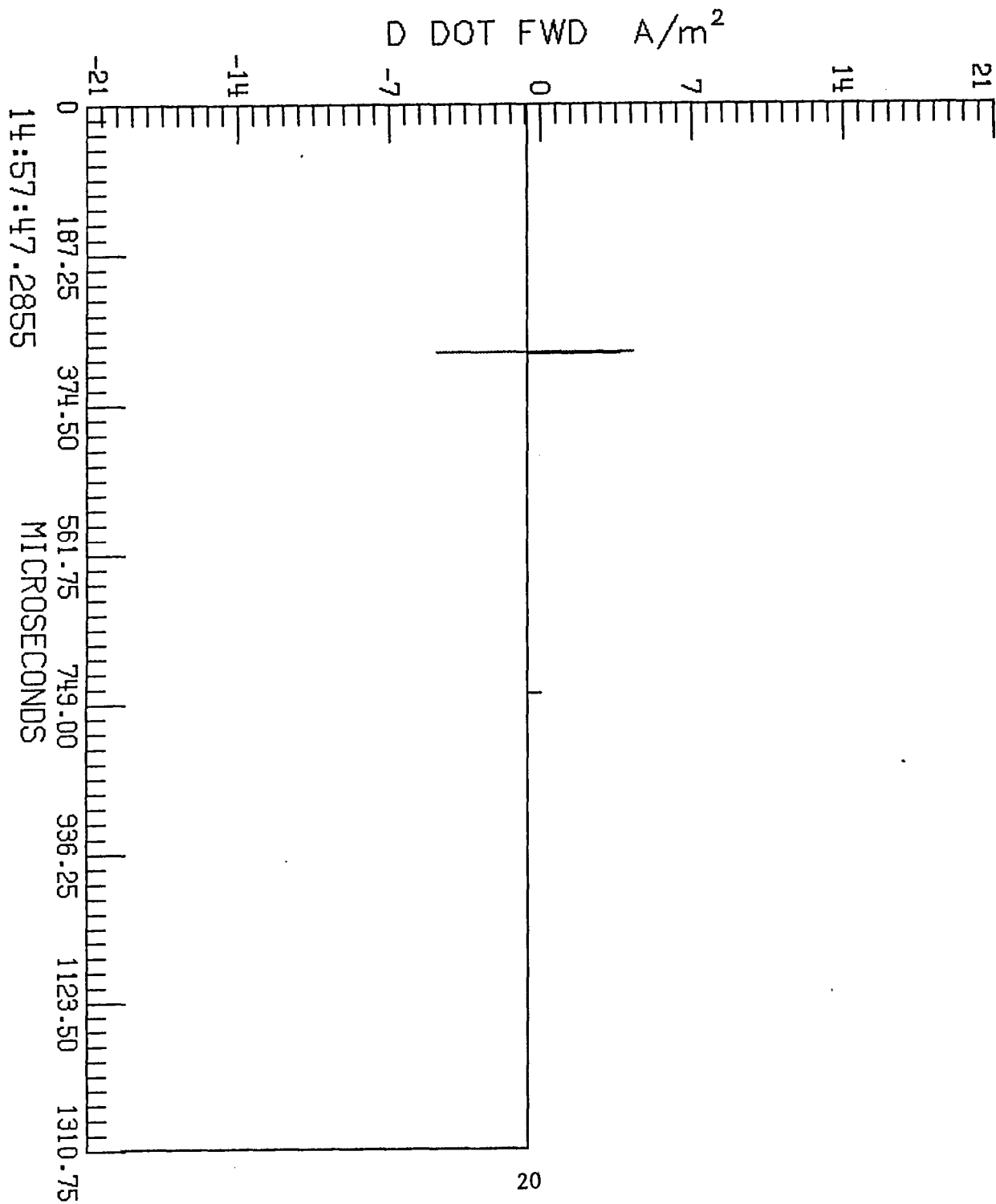
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F106 LIGHTNING/83-013/M.THOMAS

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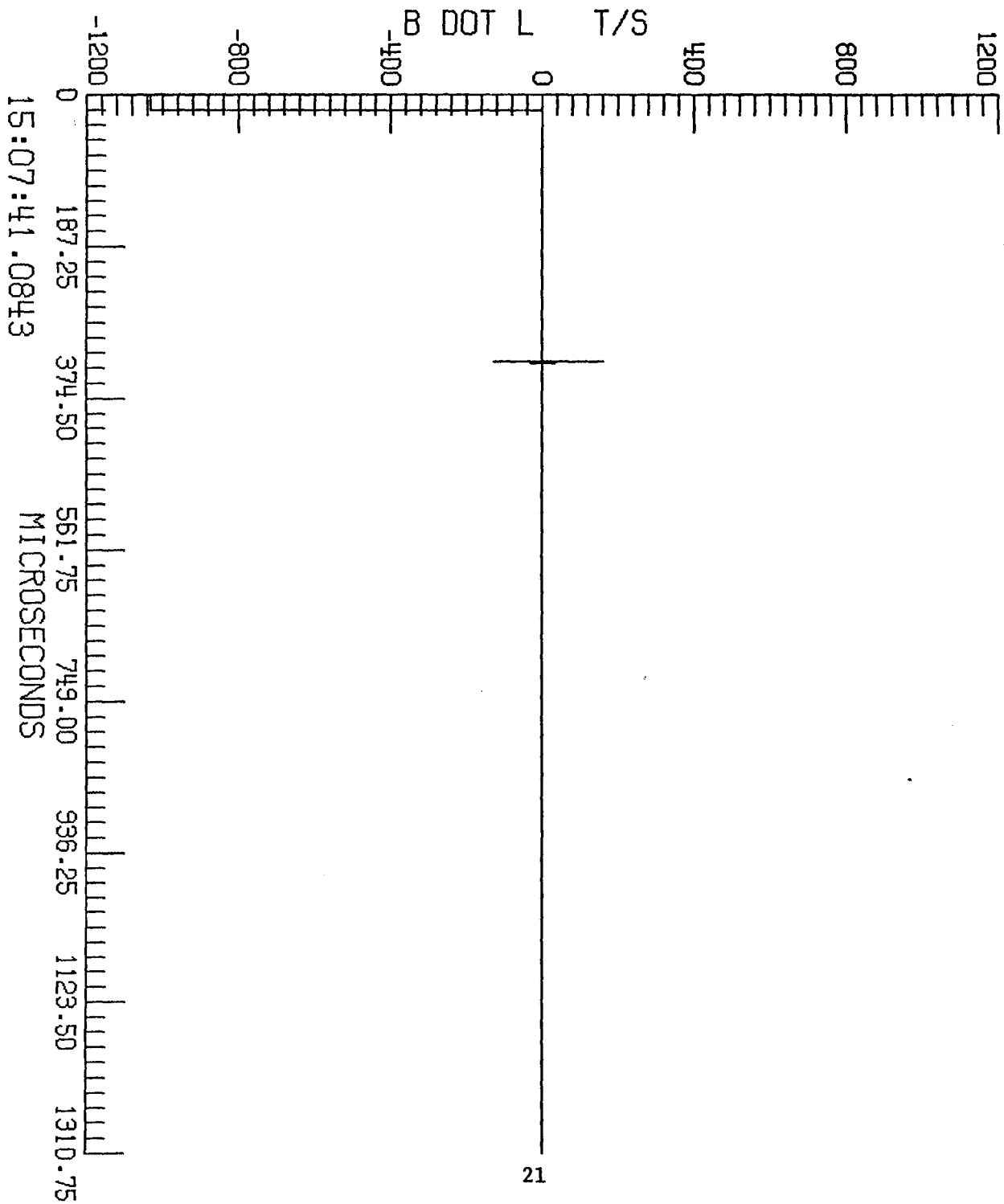
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F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83-

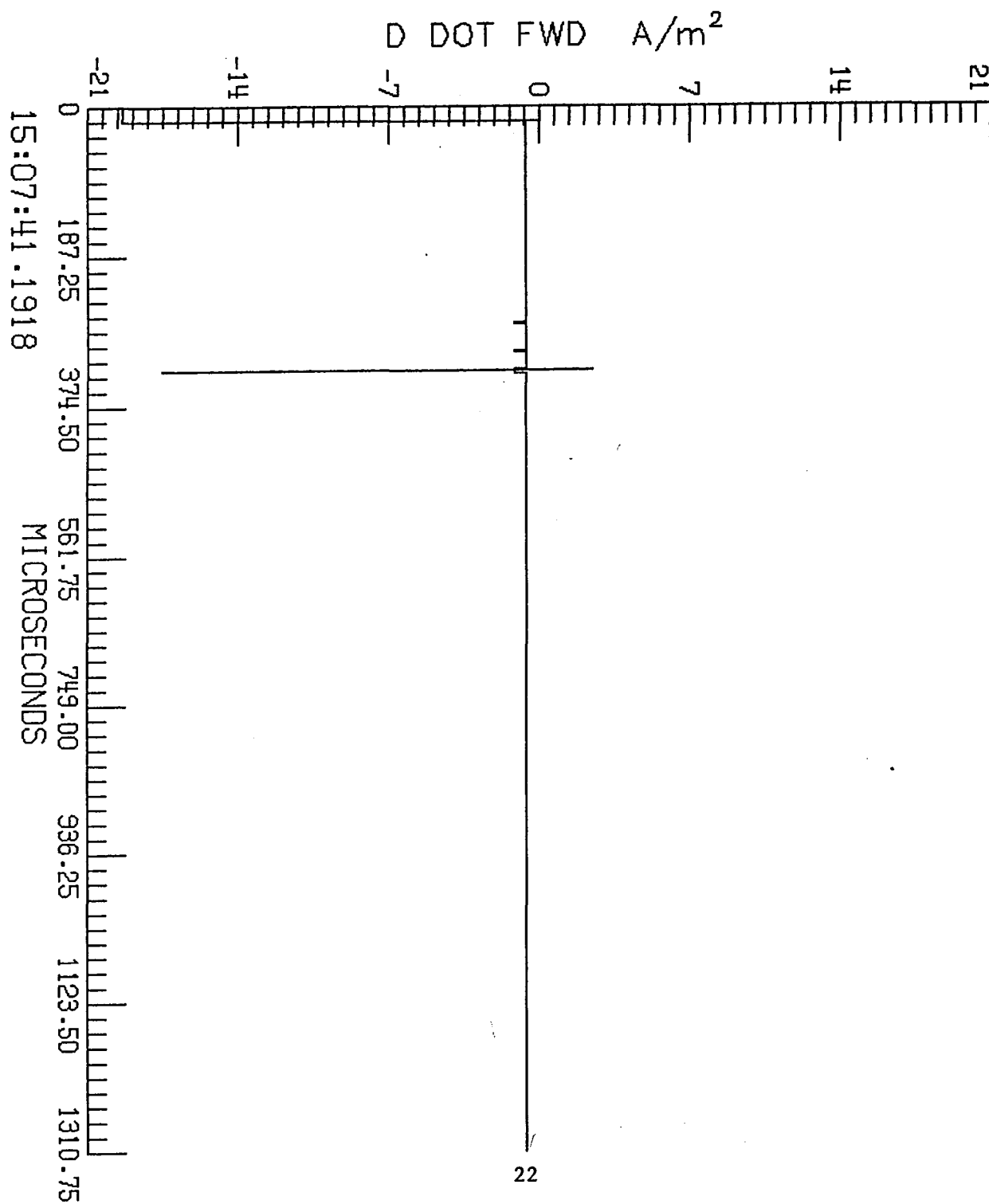
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F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

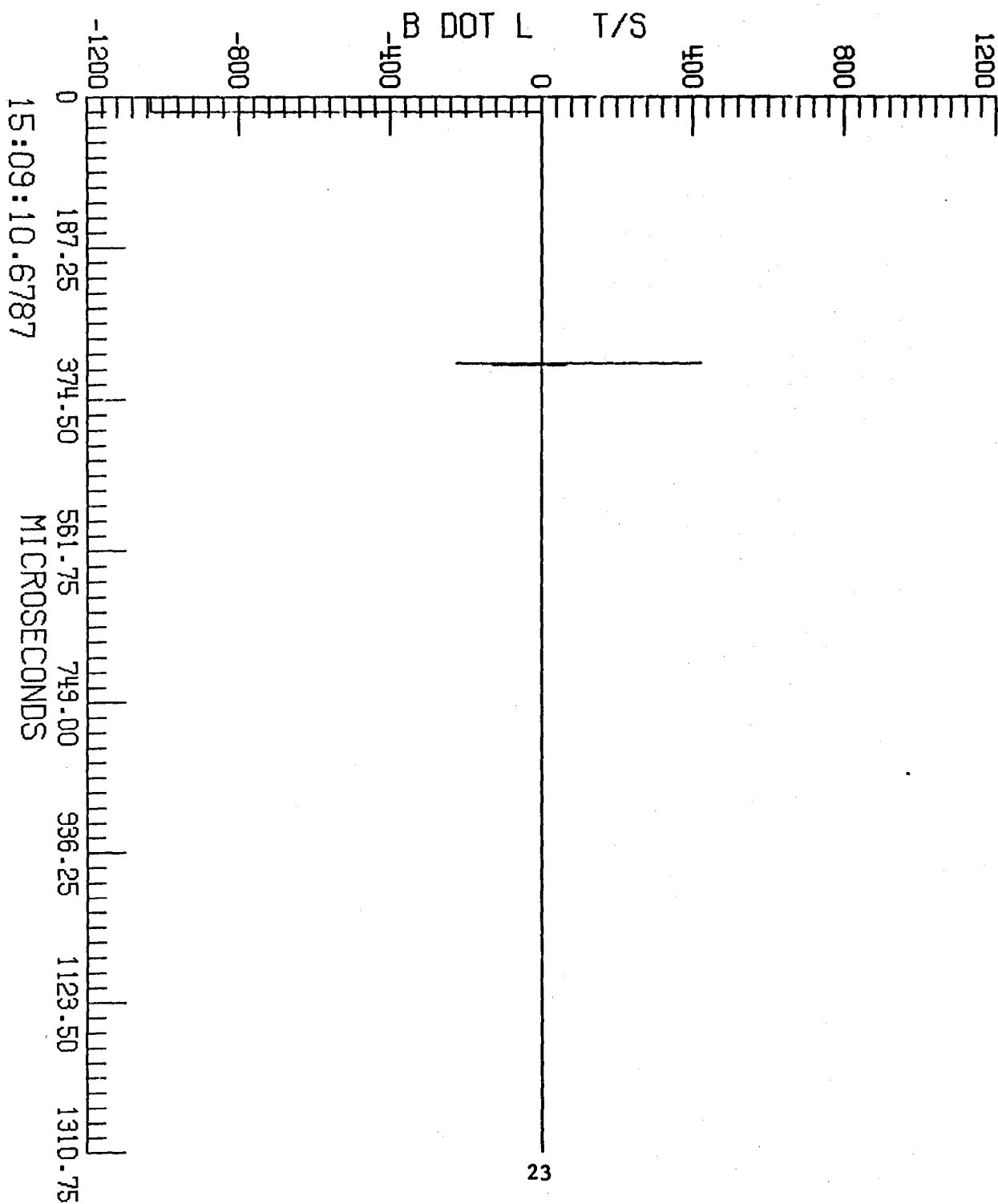
RUN NO. 2 S-002



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

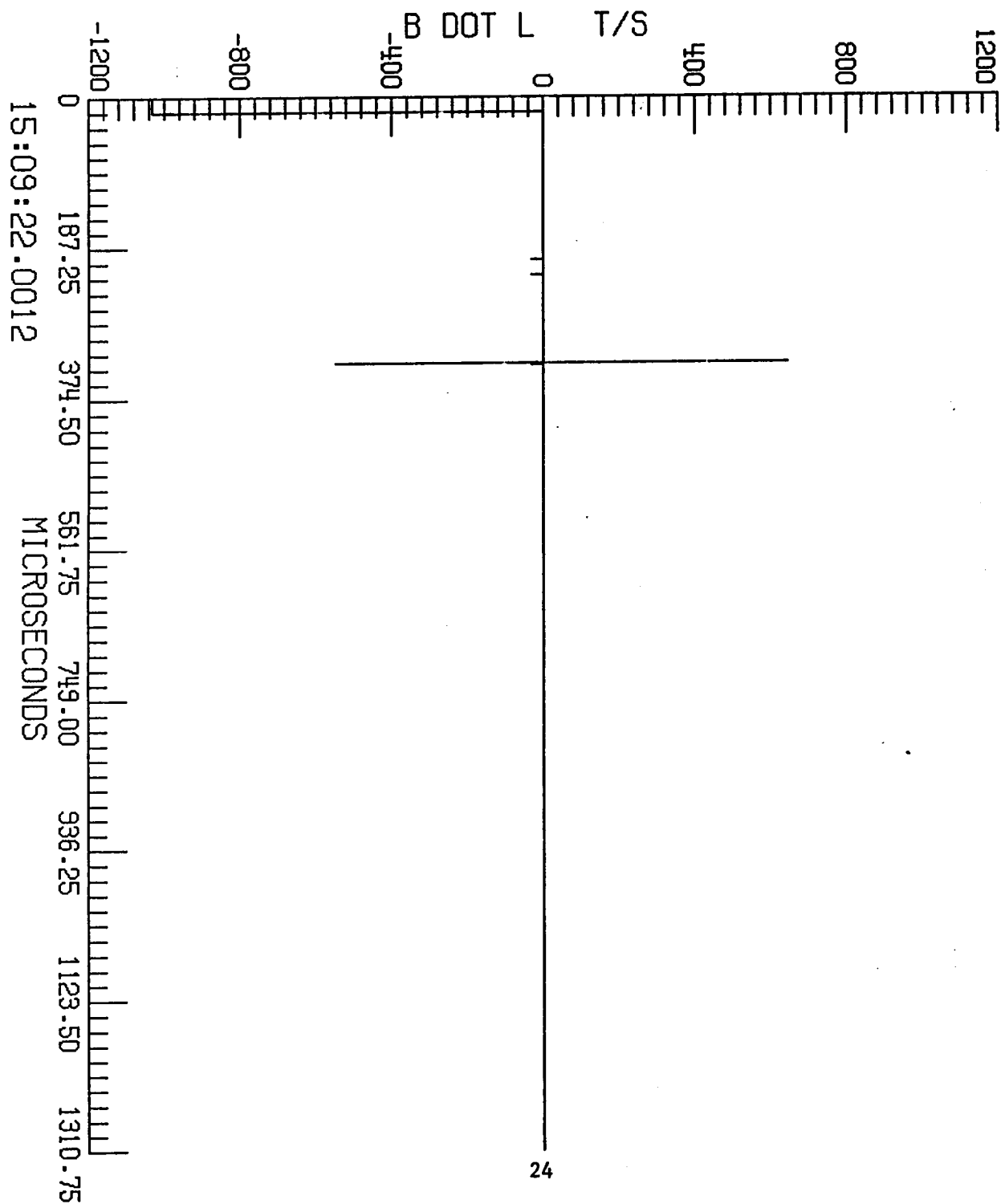
RUN NO. 3 S-003



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

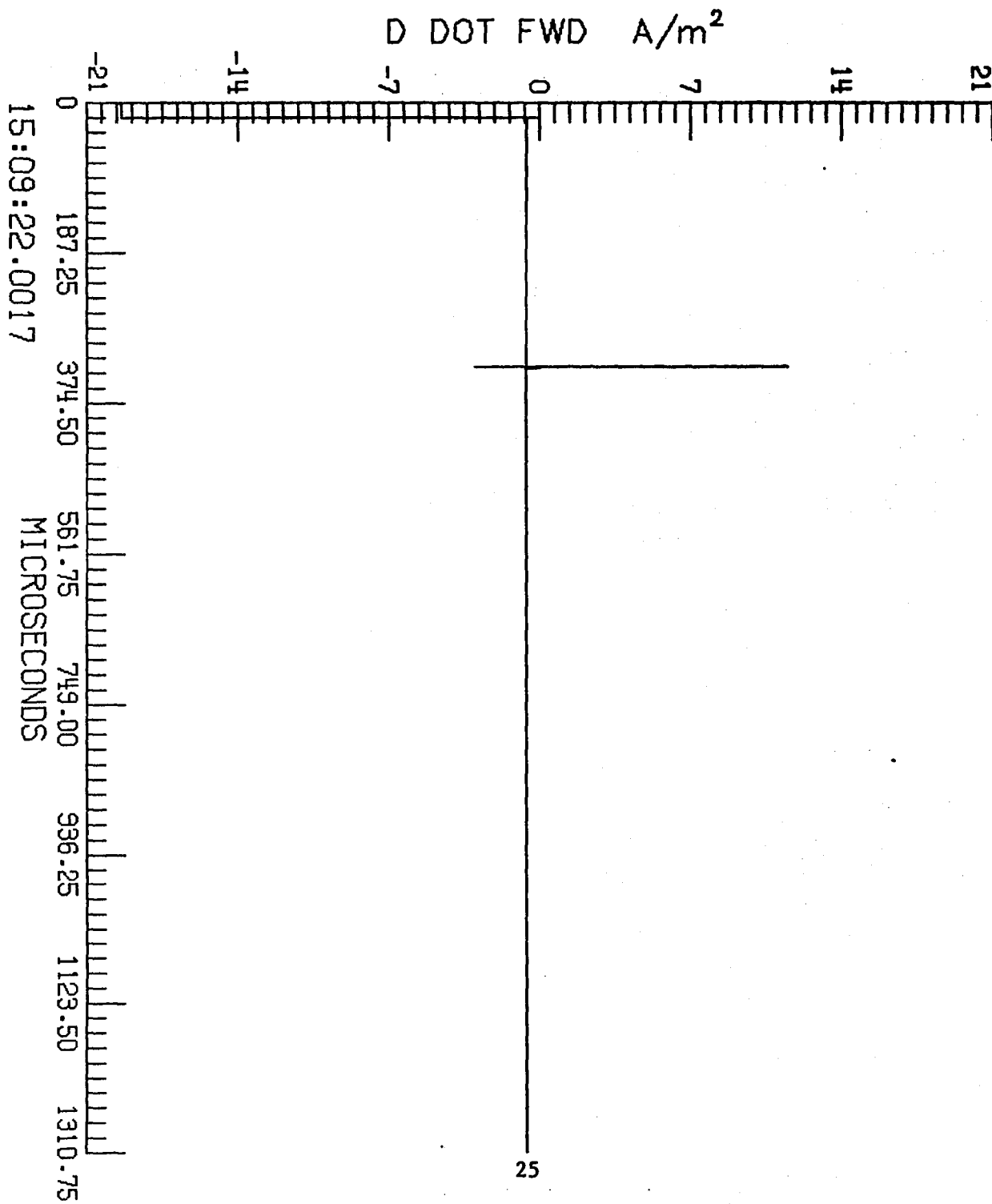
RUN NO. 4 S-004



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

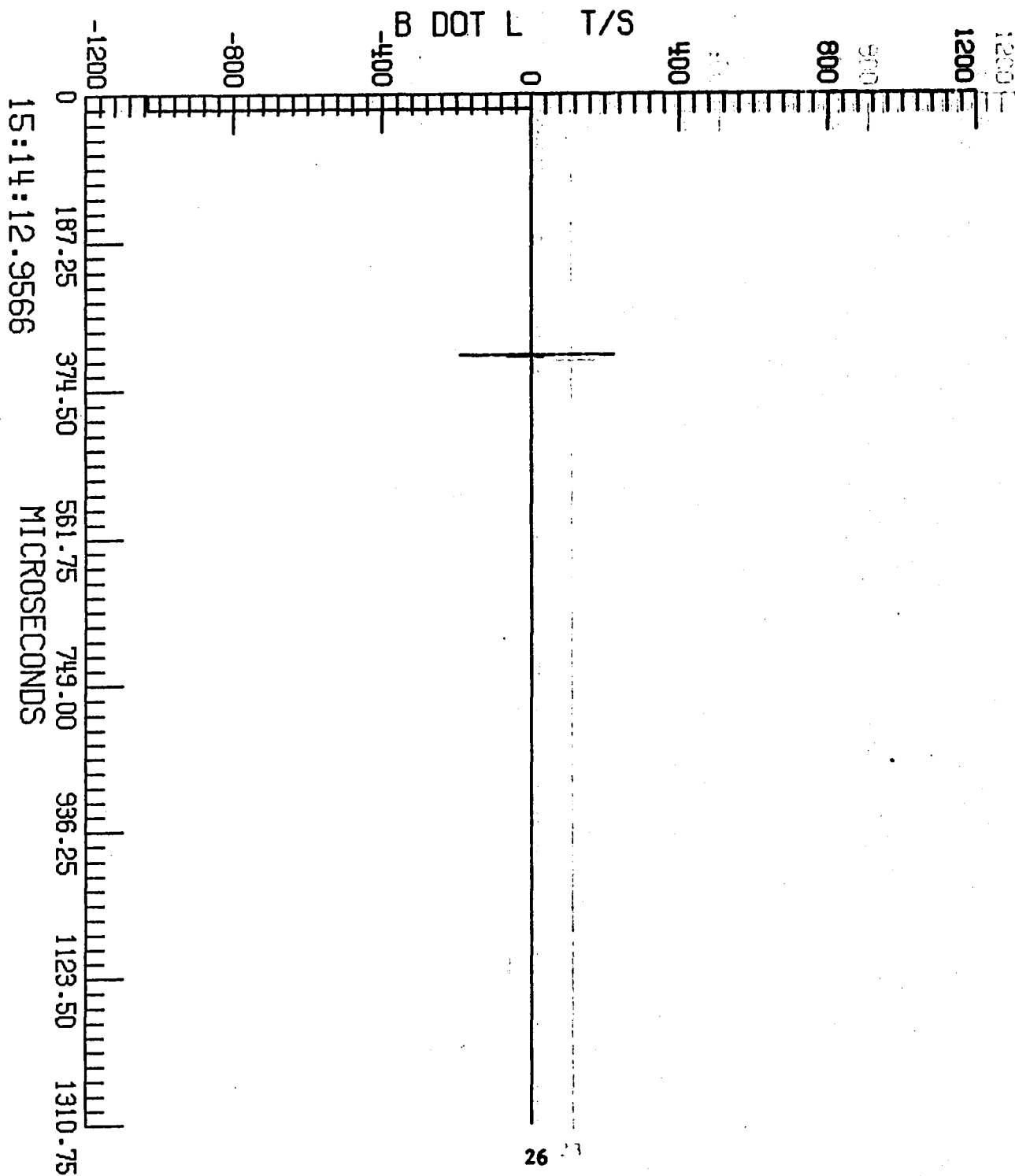
RUN NO. 4 S-004



F106 LIGHTNING/83-013/M. THOMAS

TEST NO. 83

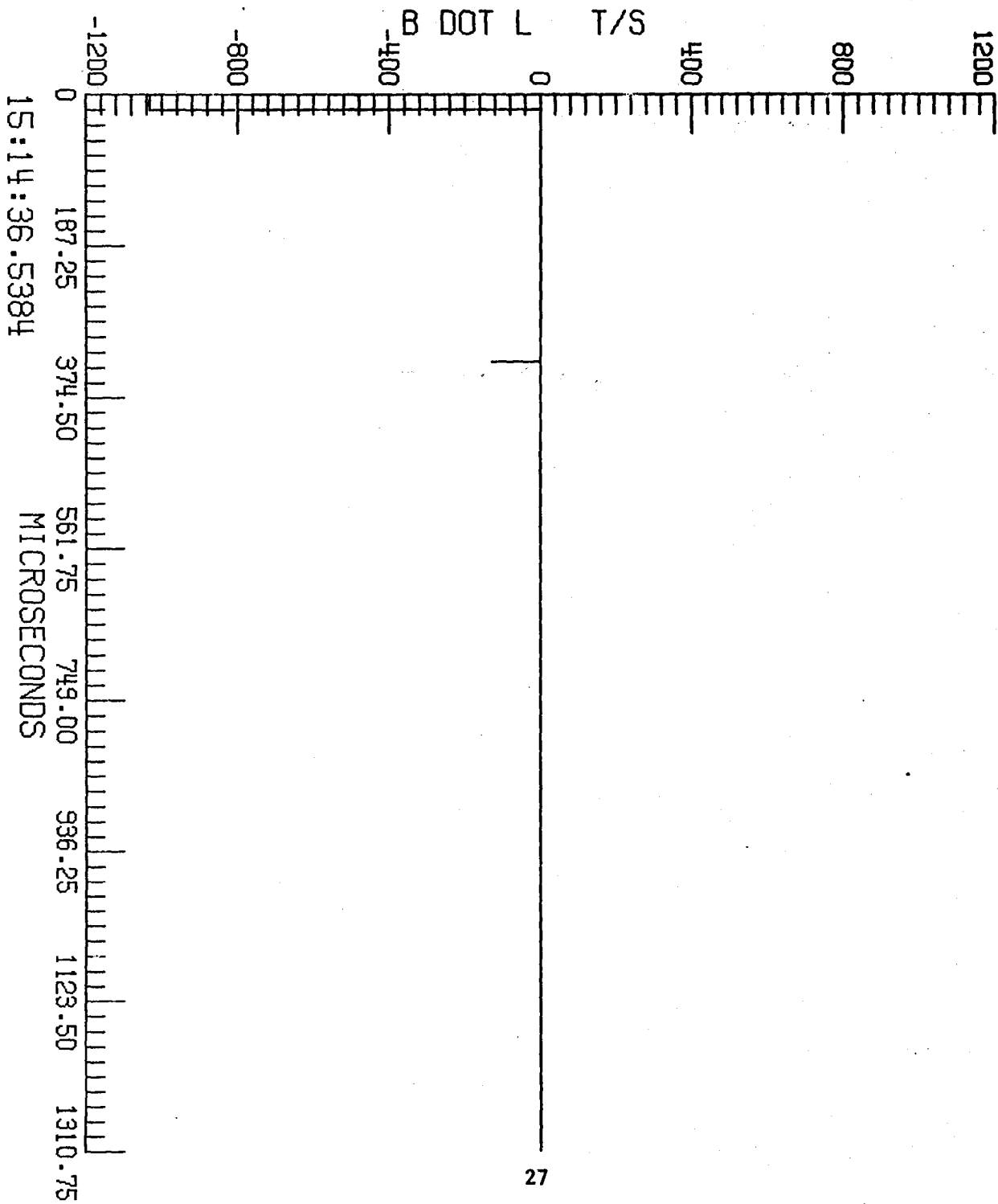
RUN NO. 5 S-005



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

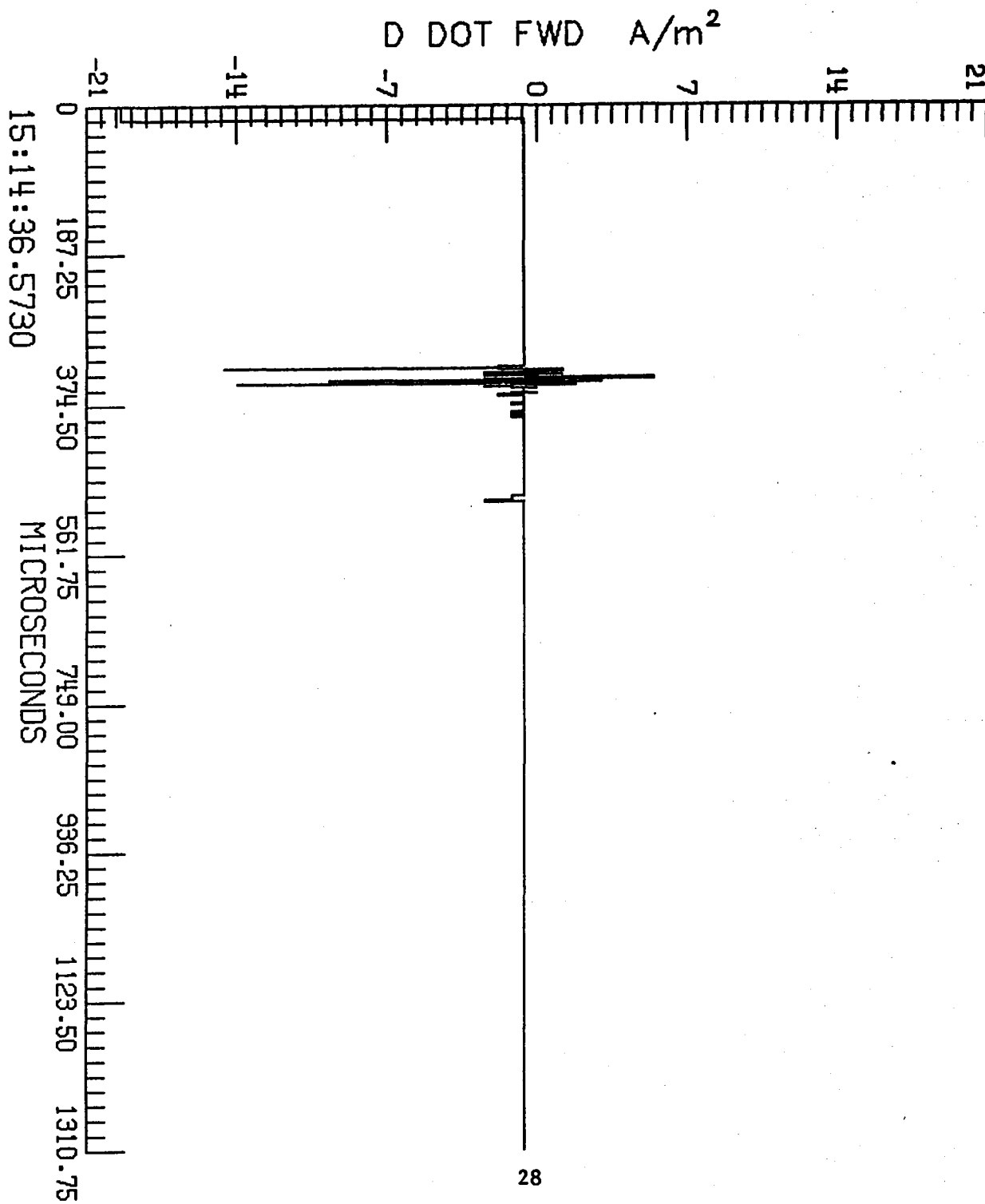
RUN NO. 6 S-006



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

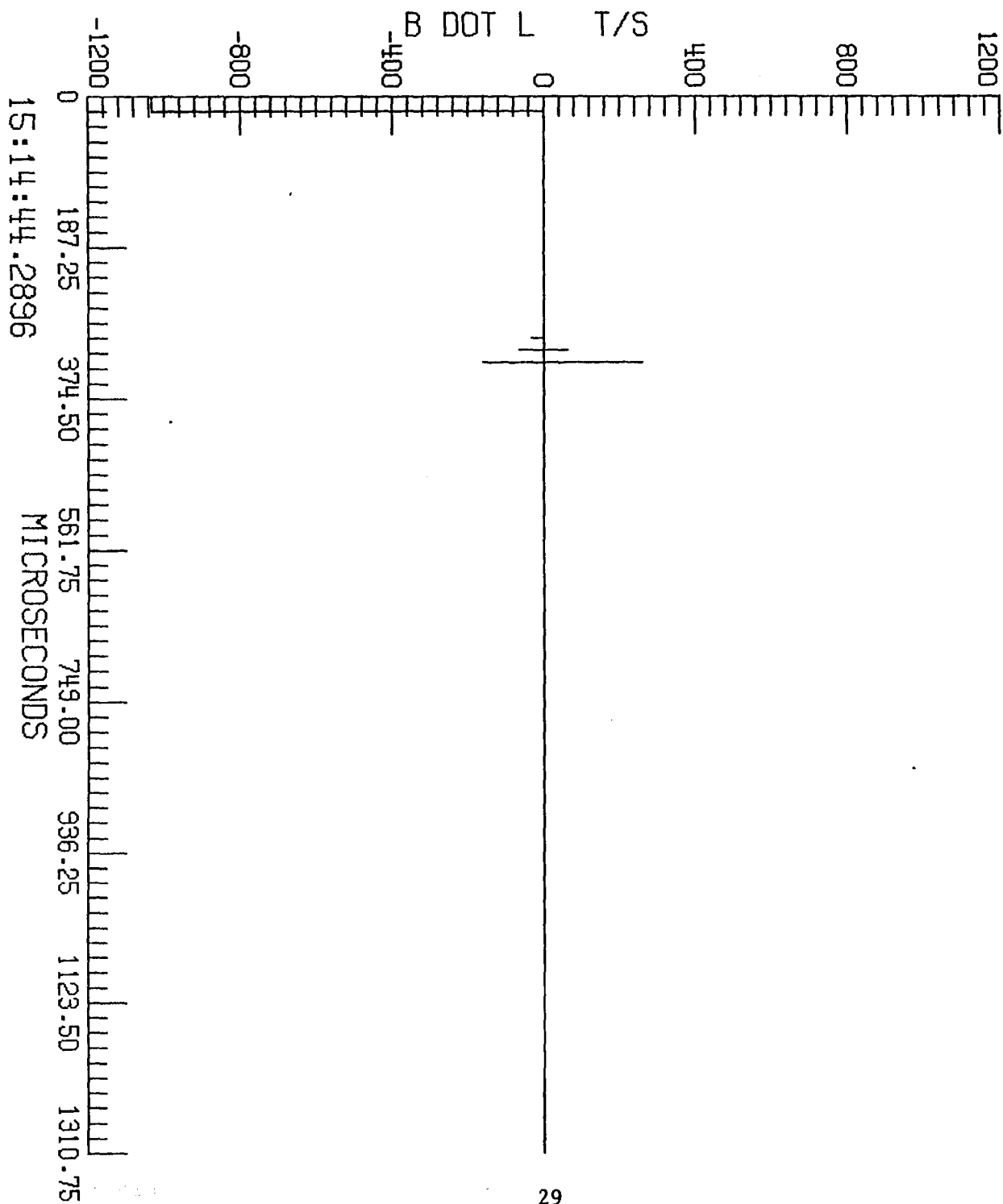
RUN NO. 6 S-006



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

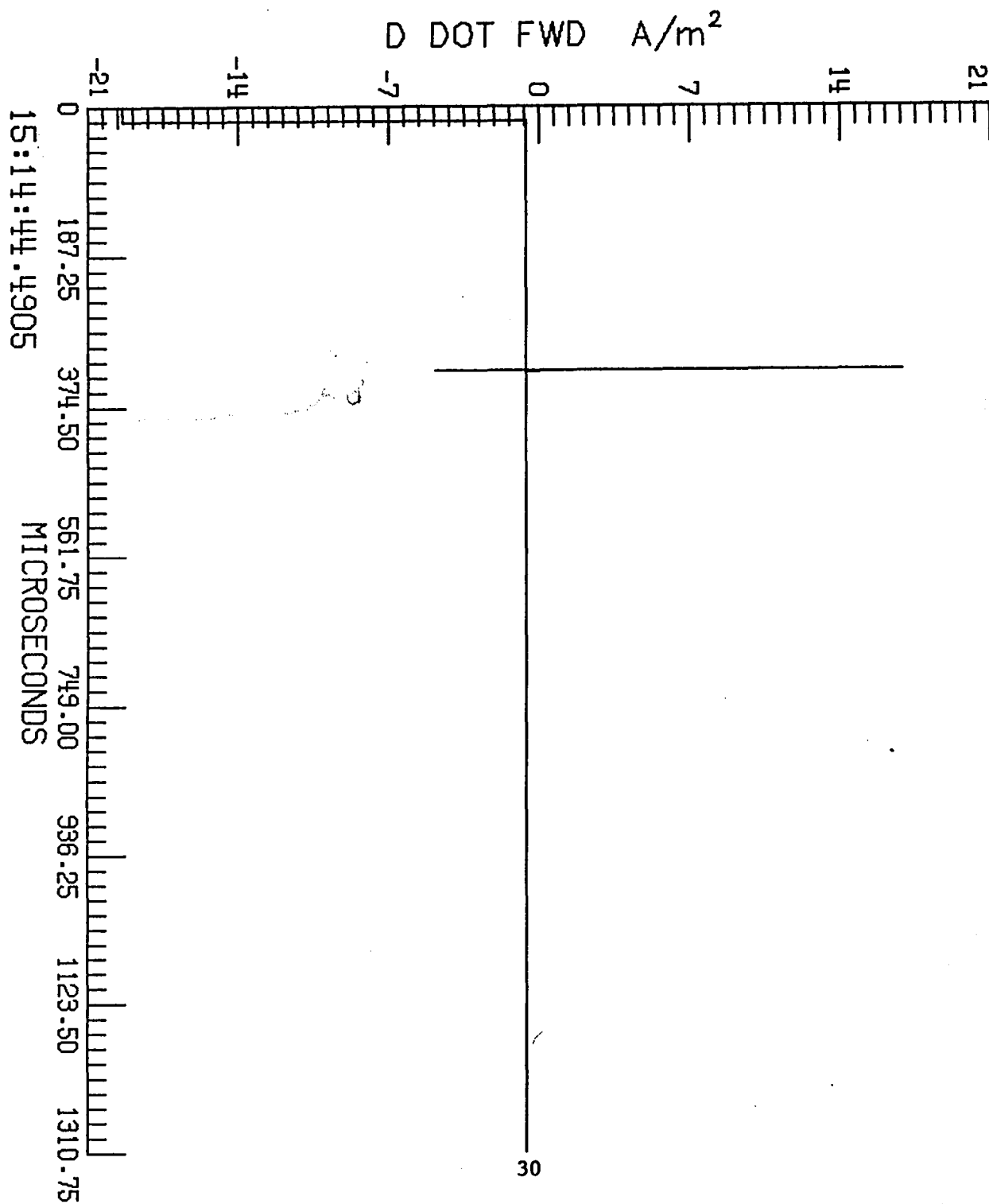
RUN NO. 7 S-007



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

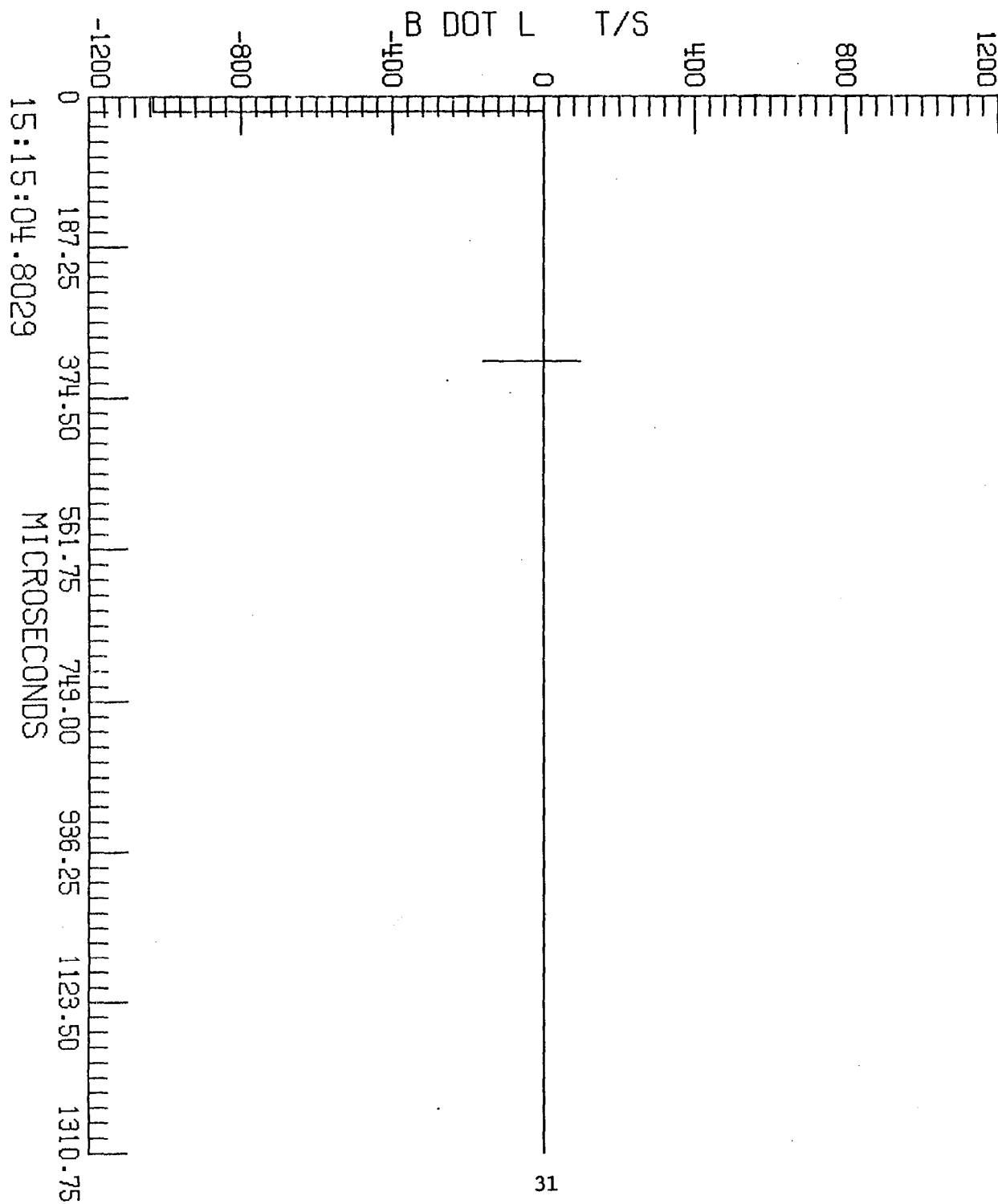
RUN NO. 7 S-007



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

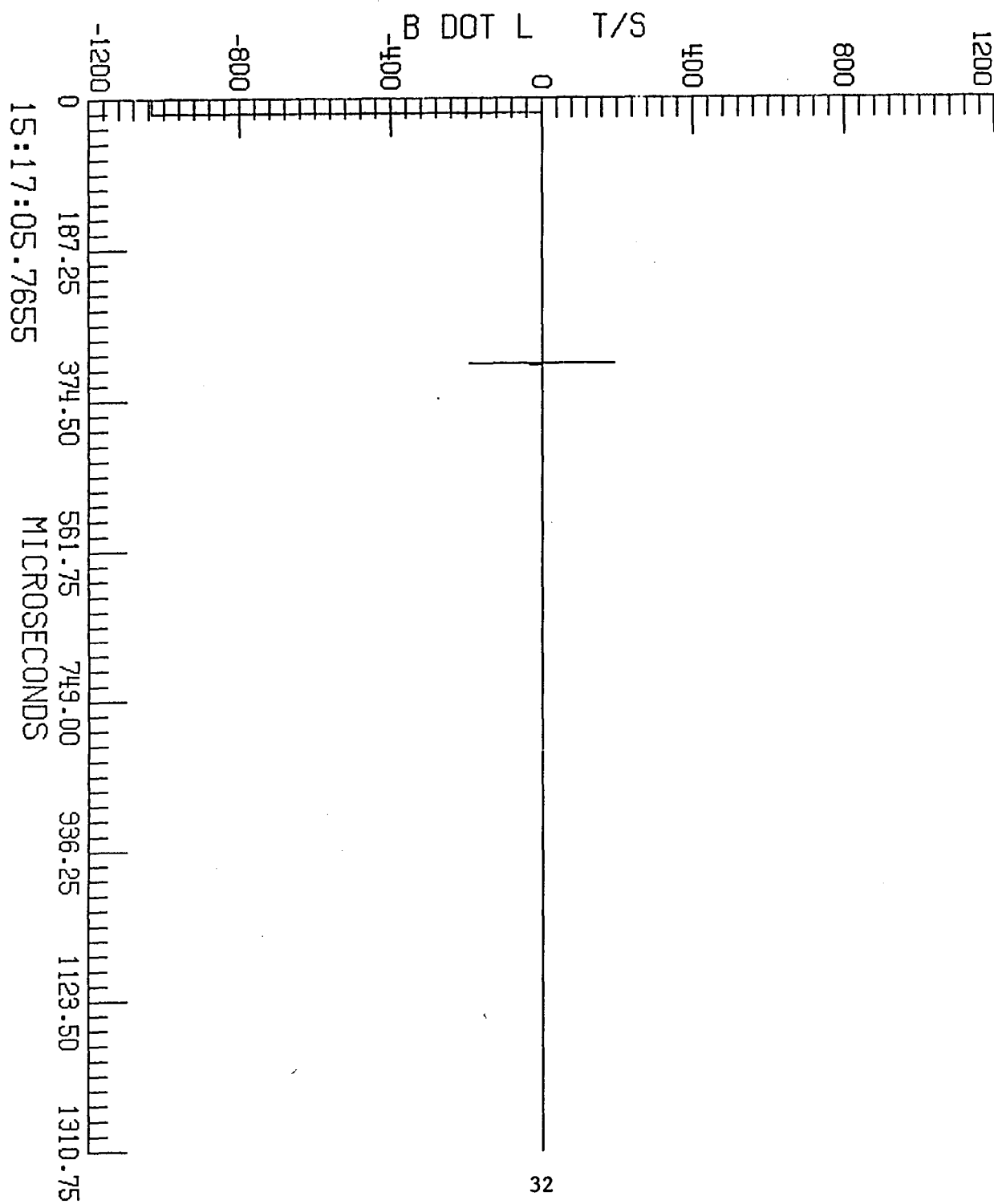
RUN NO. 8 N-001



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

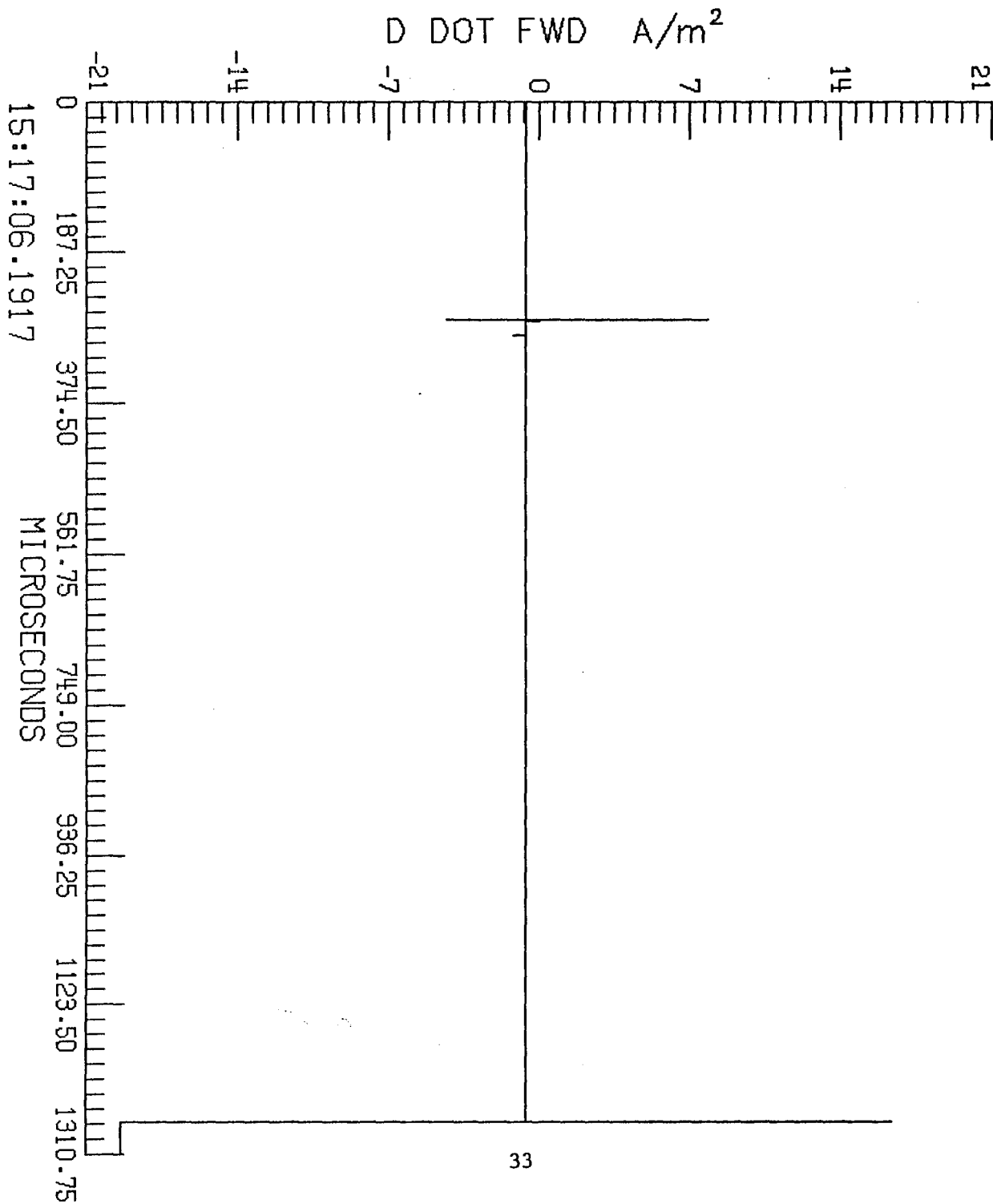
RUN NO. 9 S-009



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

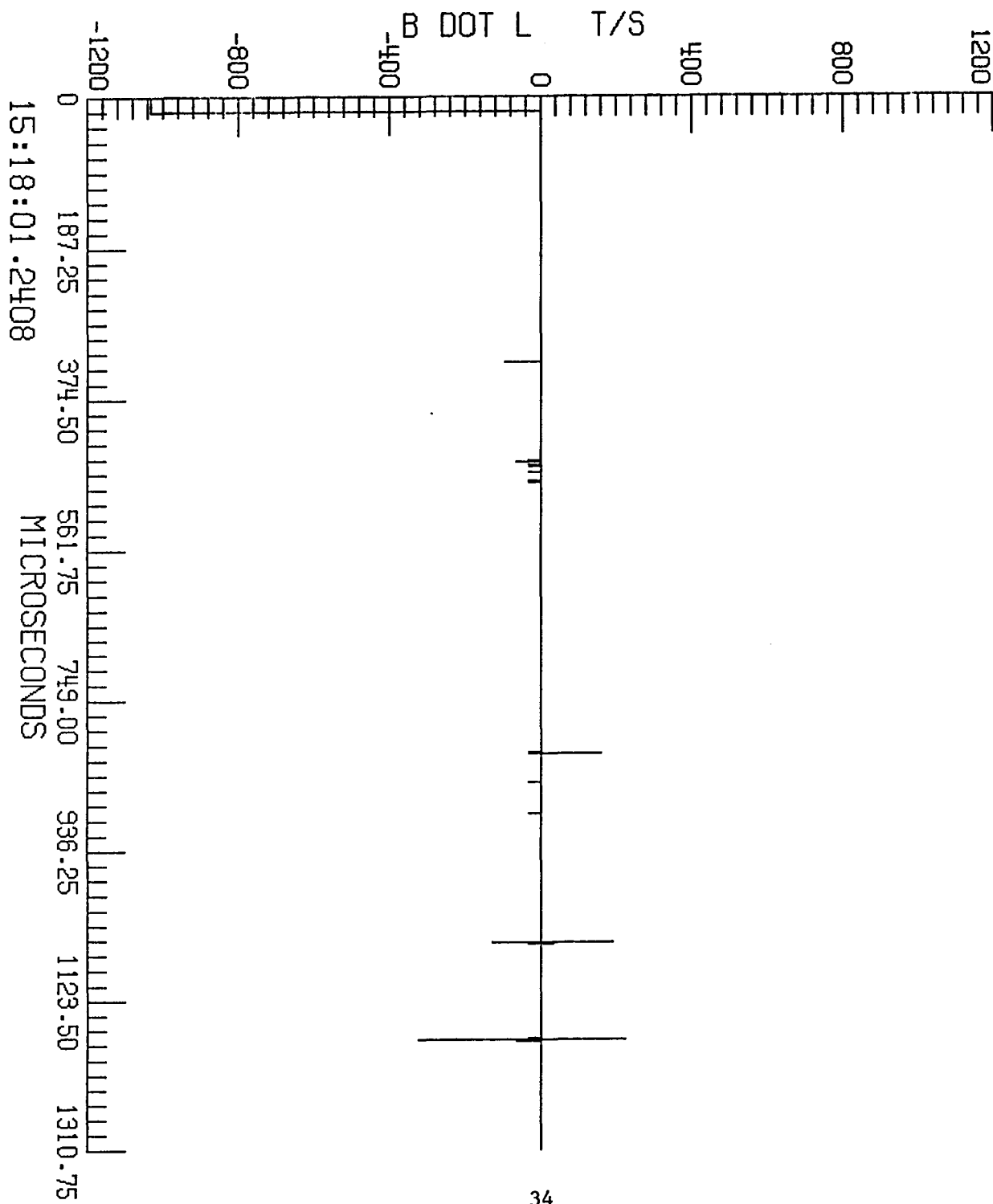
RUN NO. 9 S-009



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

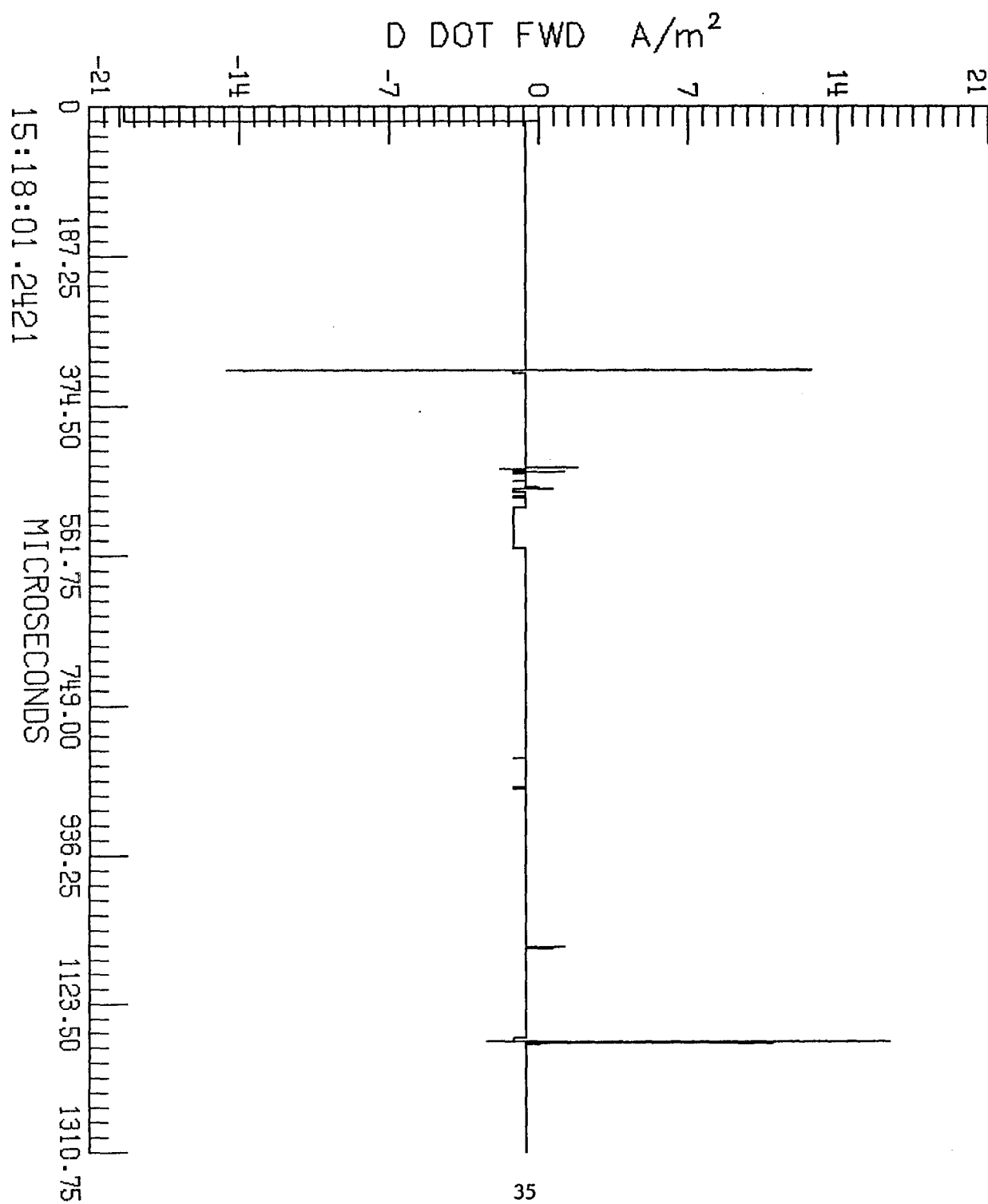
RUN NO. 10 S-010



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

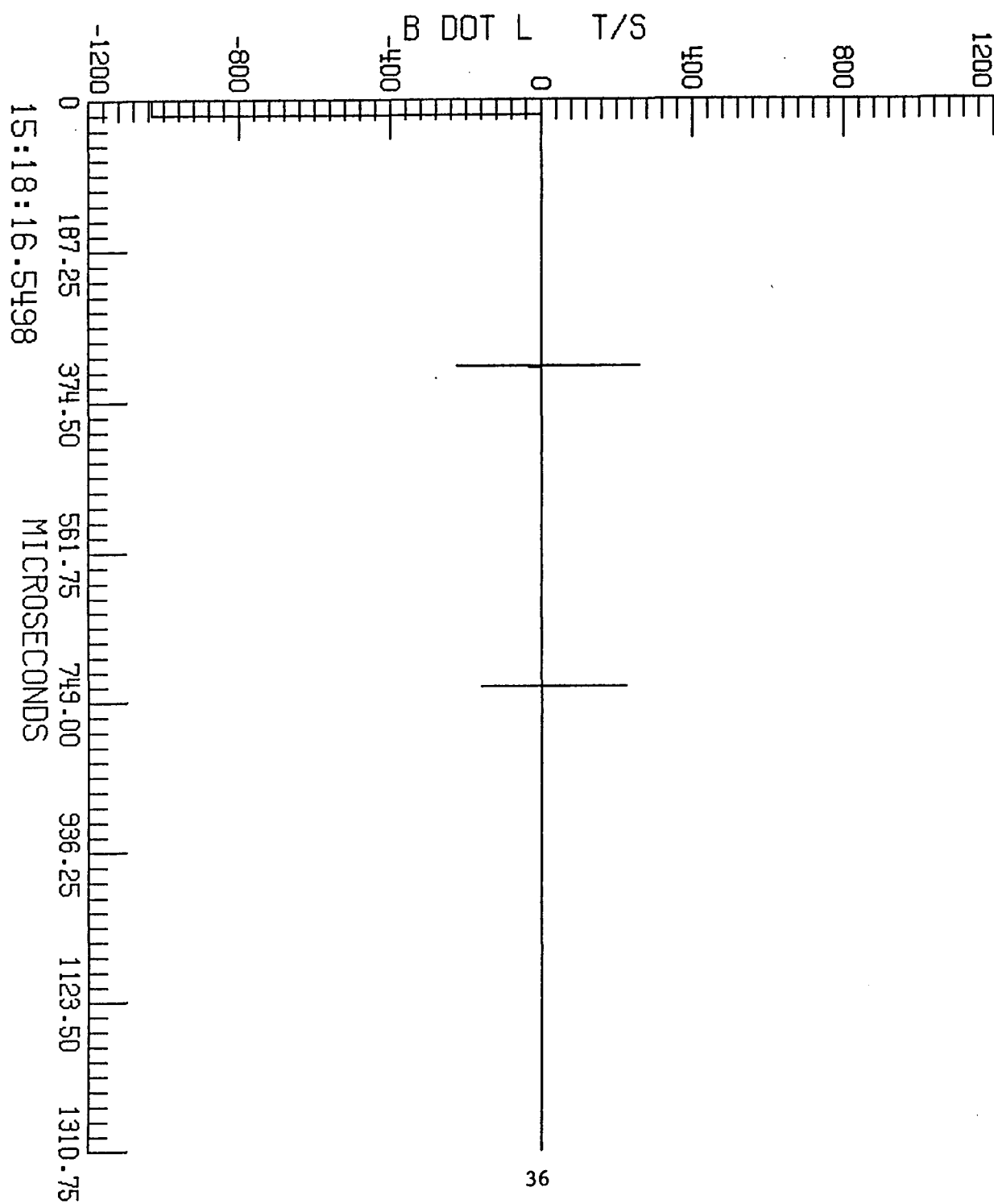
RUN NO. 10 S-010



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

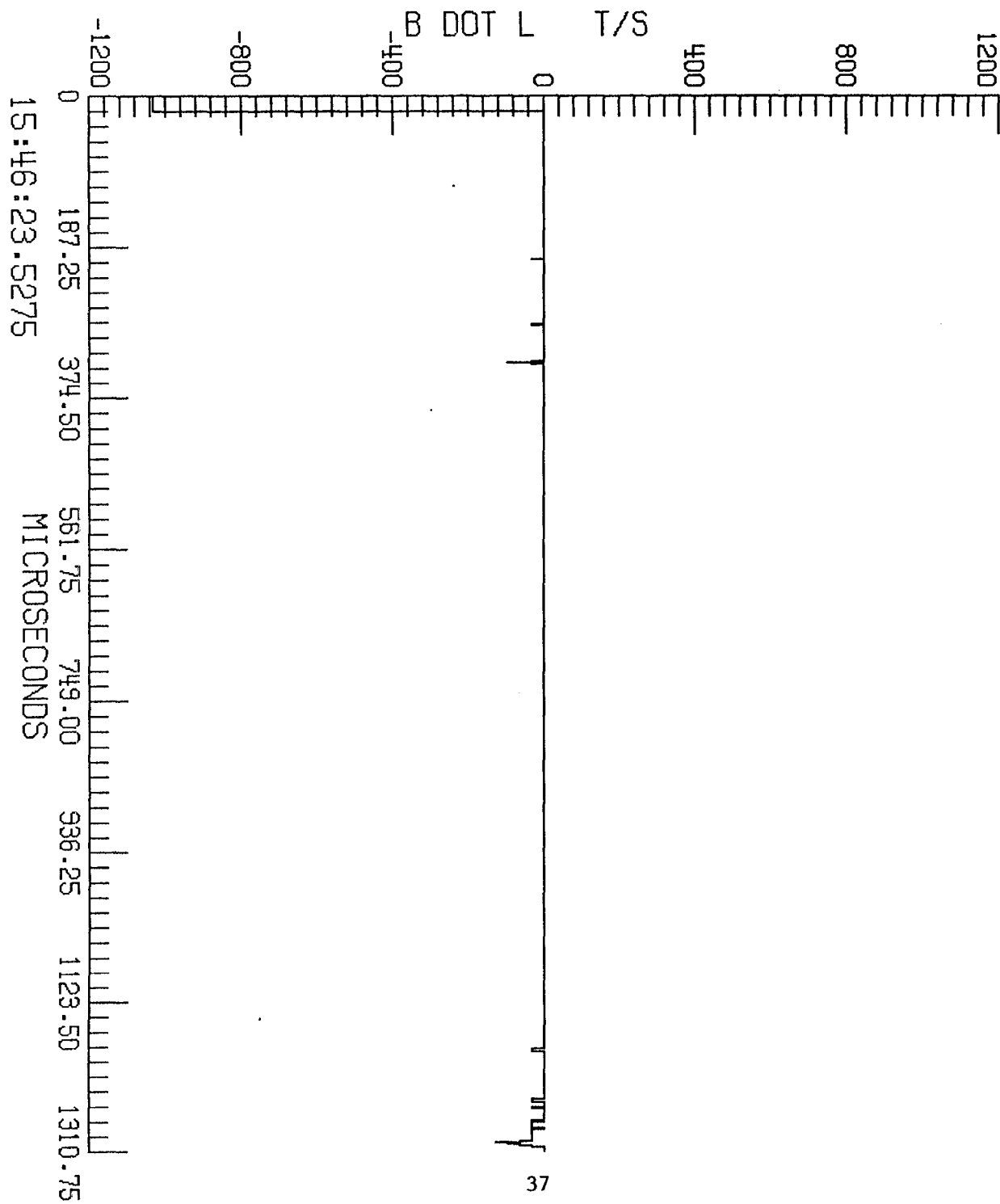
RUN NO. 11 S-011



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

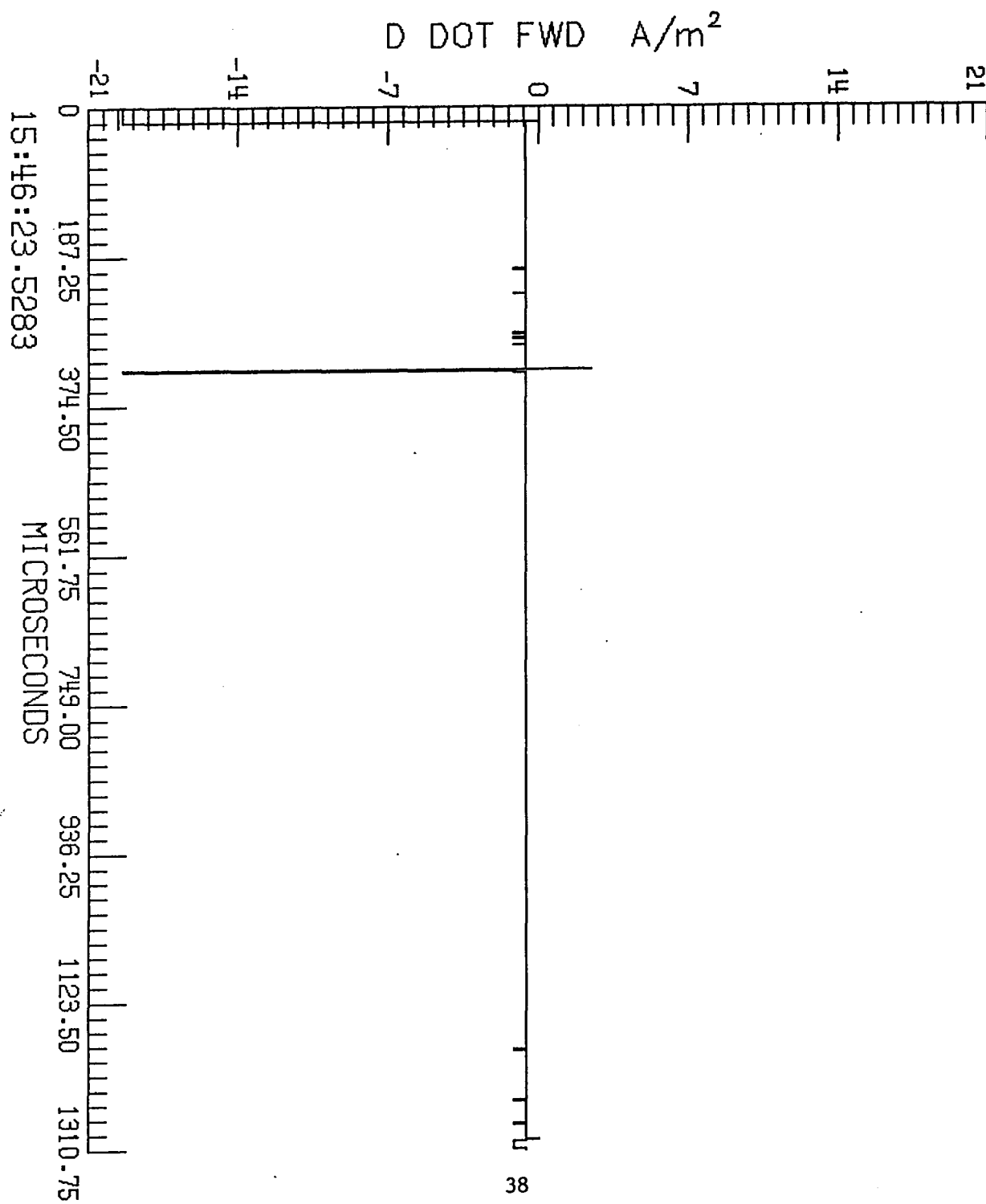
RUN NO. 12 S-012



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

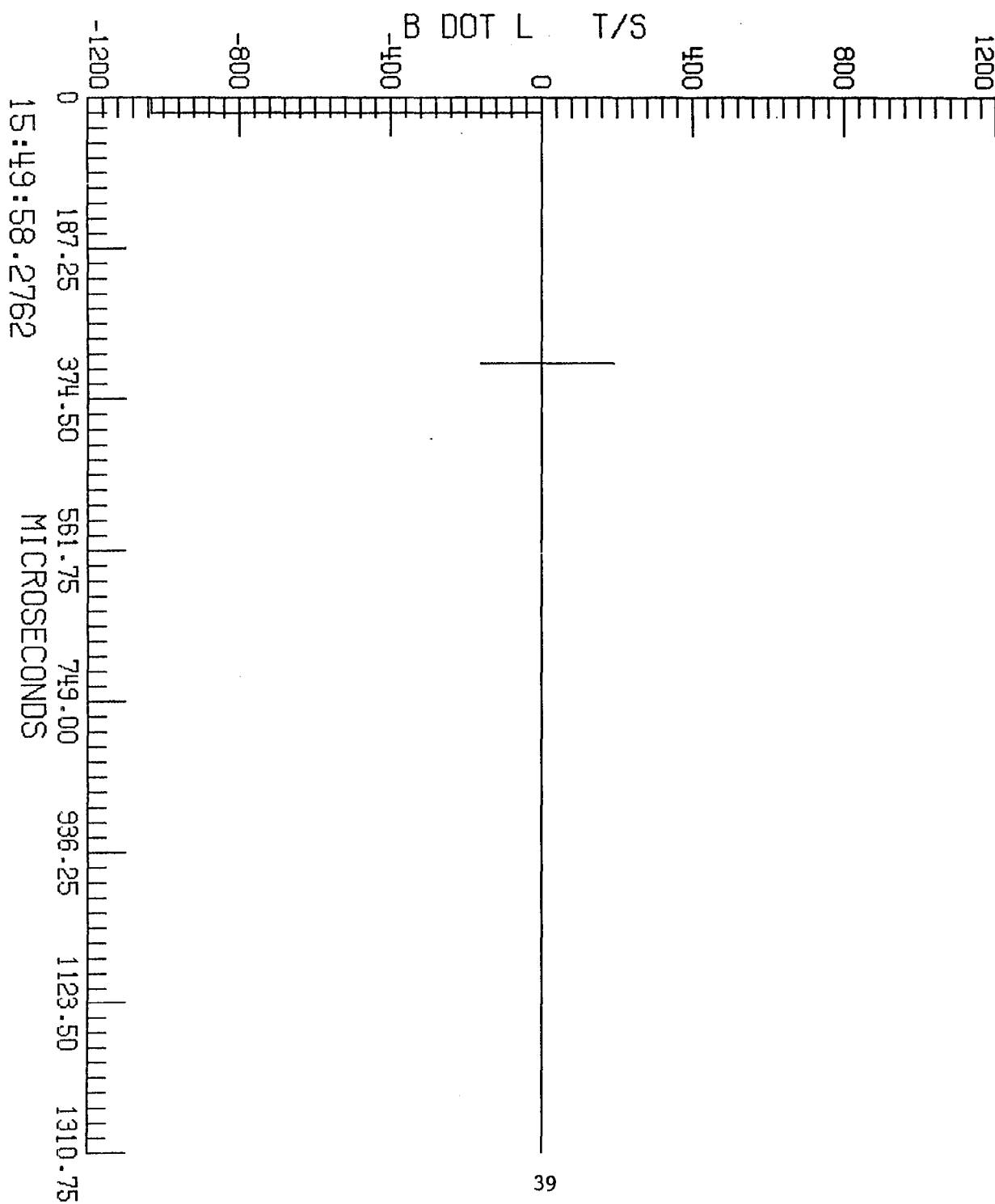
RUN NO. 12 S-012



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

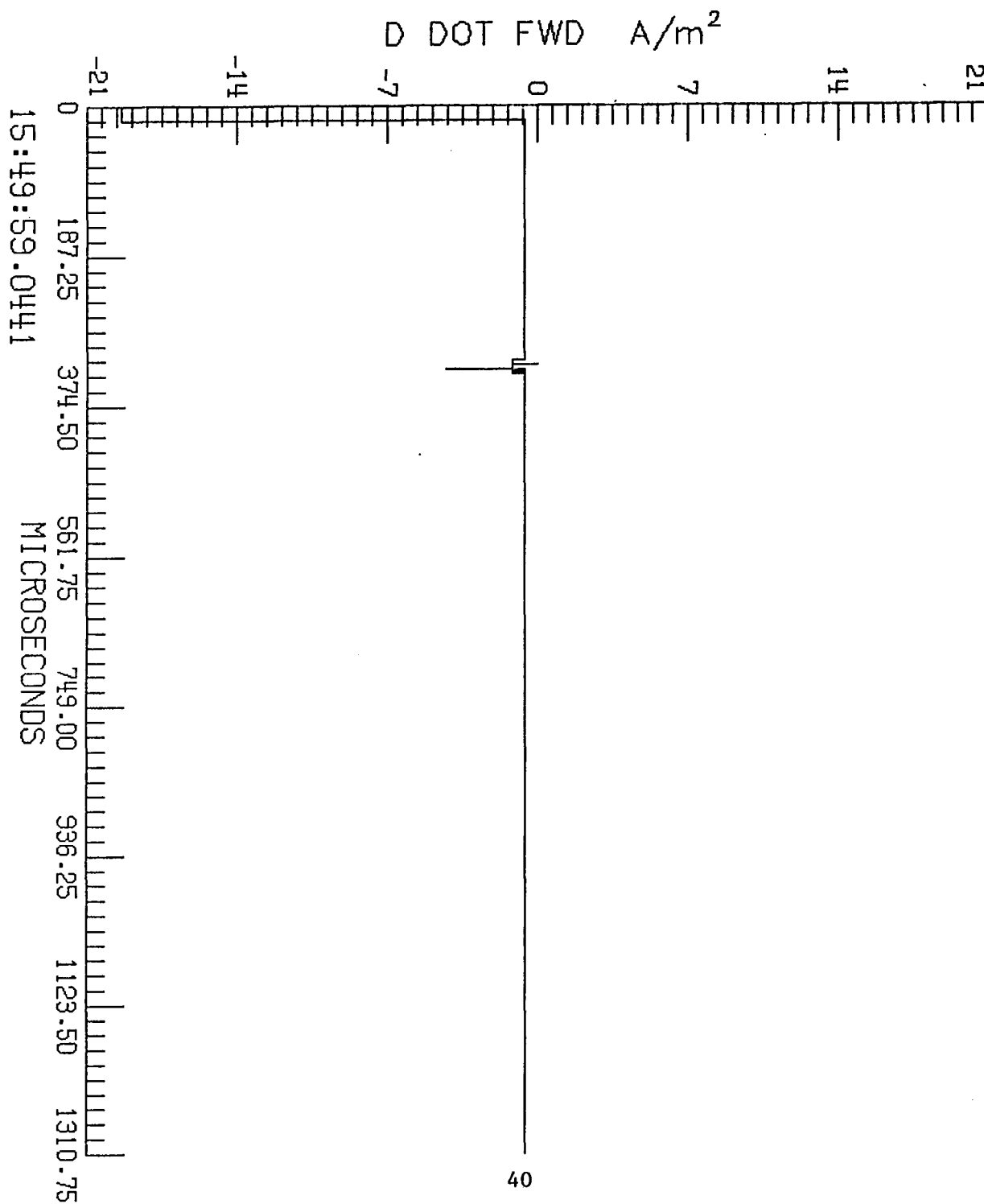
RUN NO. 13 S-013



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

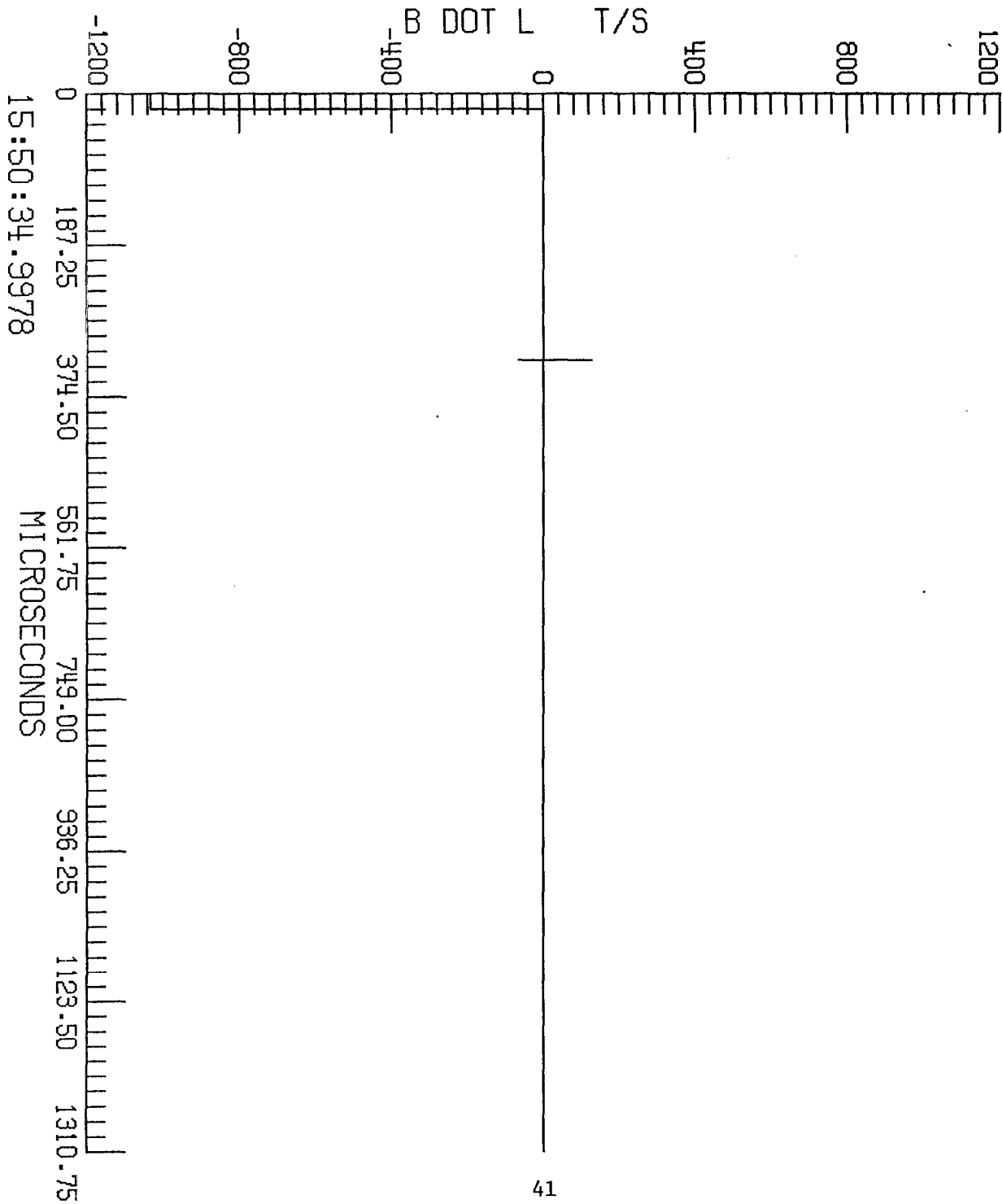
RUN NO. 13 S-013



F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

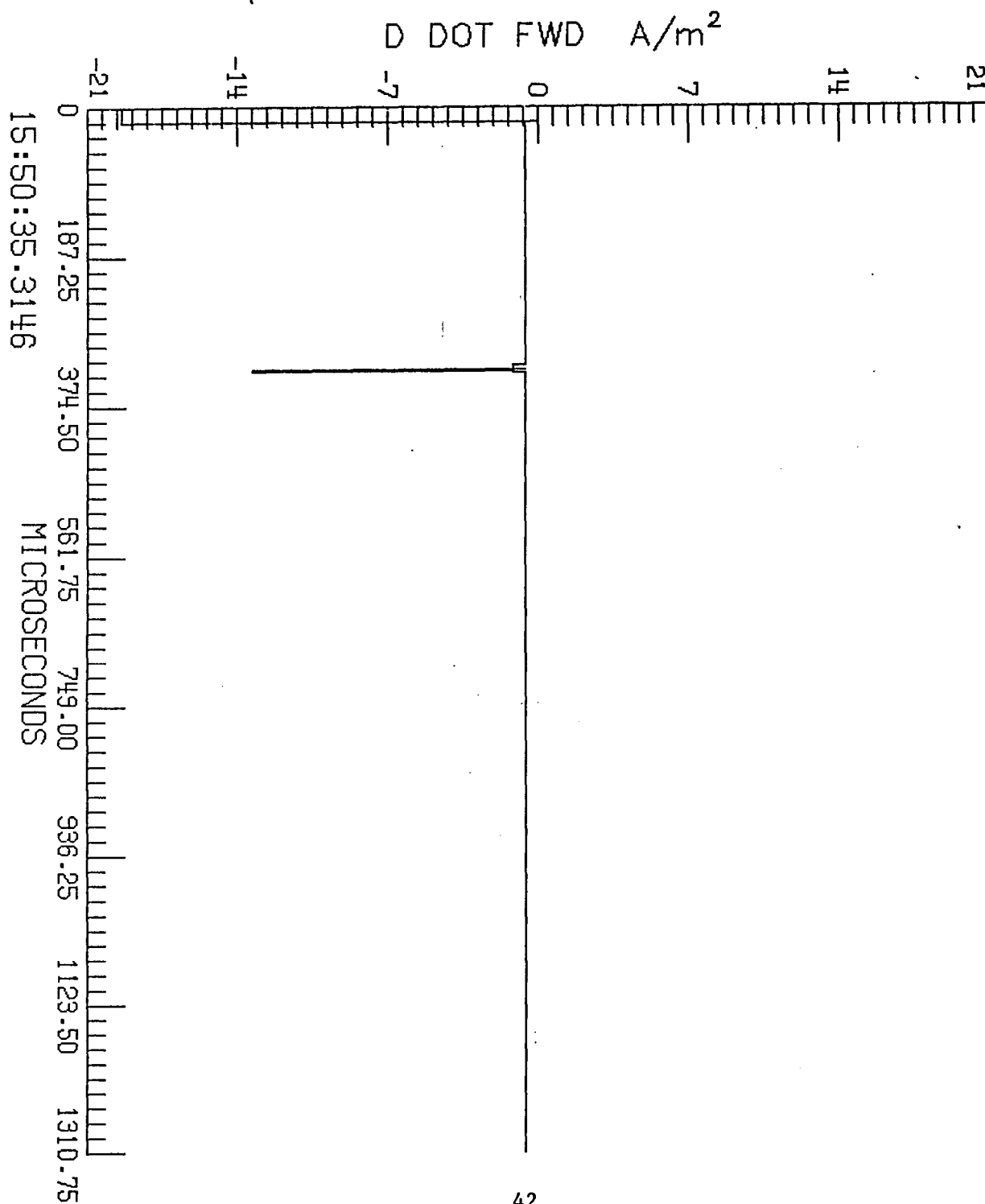
RUN NO. 14 S-014



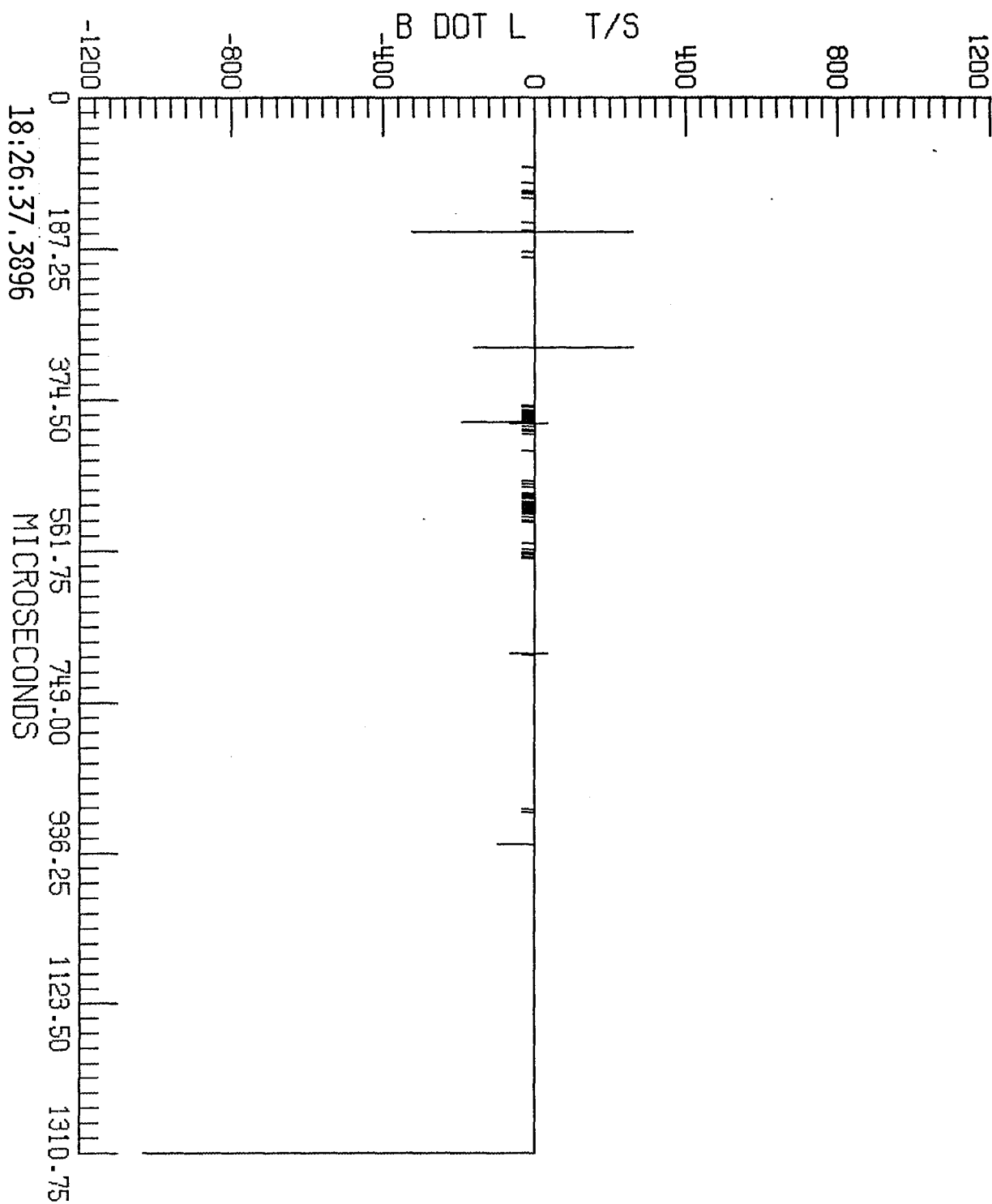
F106 LIGHTNING/83-013/M.THOMAS

TEST NO. 83

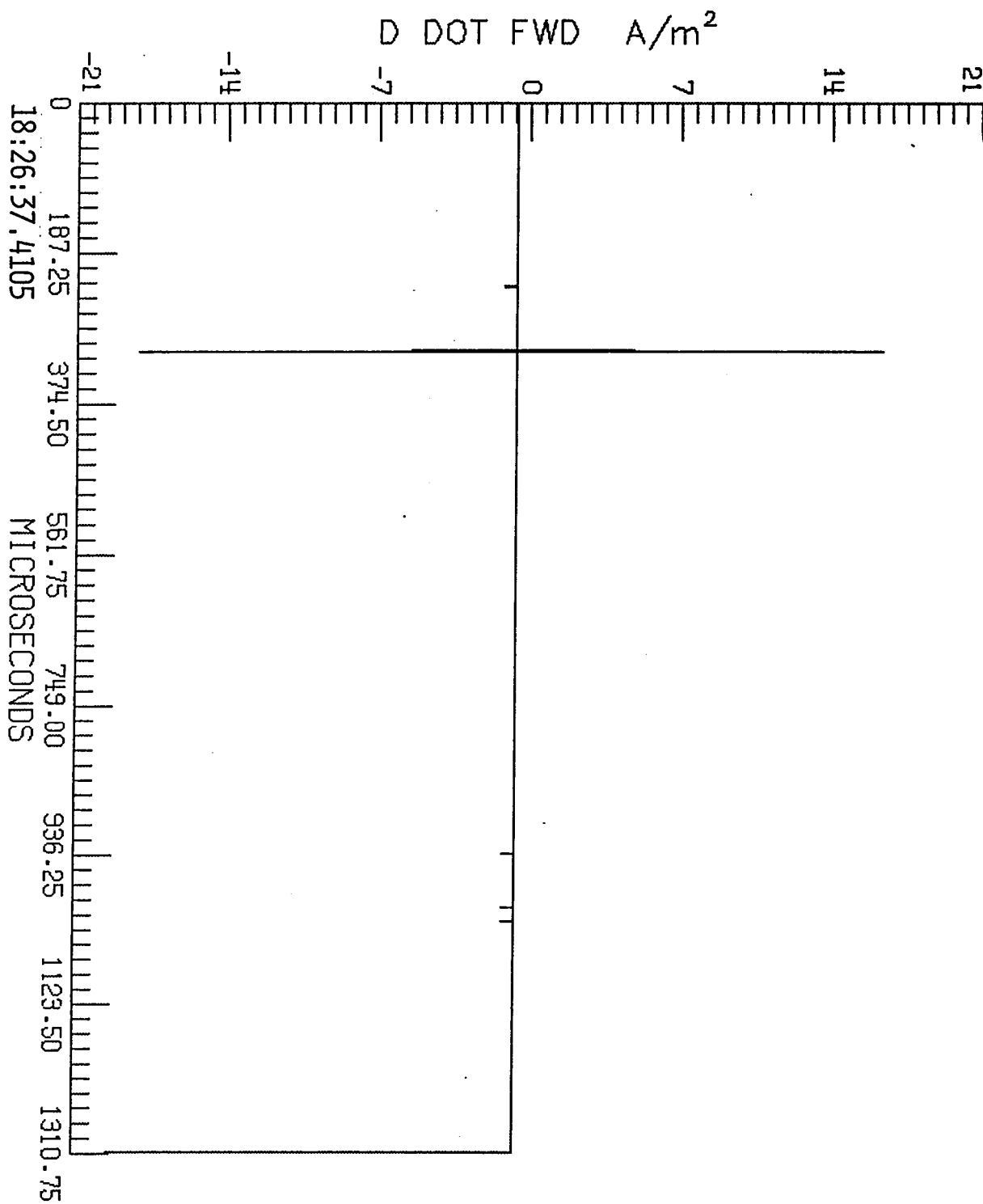
RUN NO. 14 S-014



RUN NO. 1 S-001



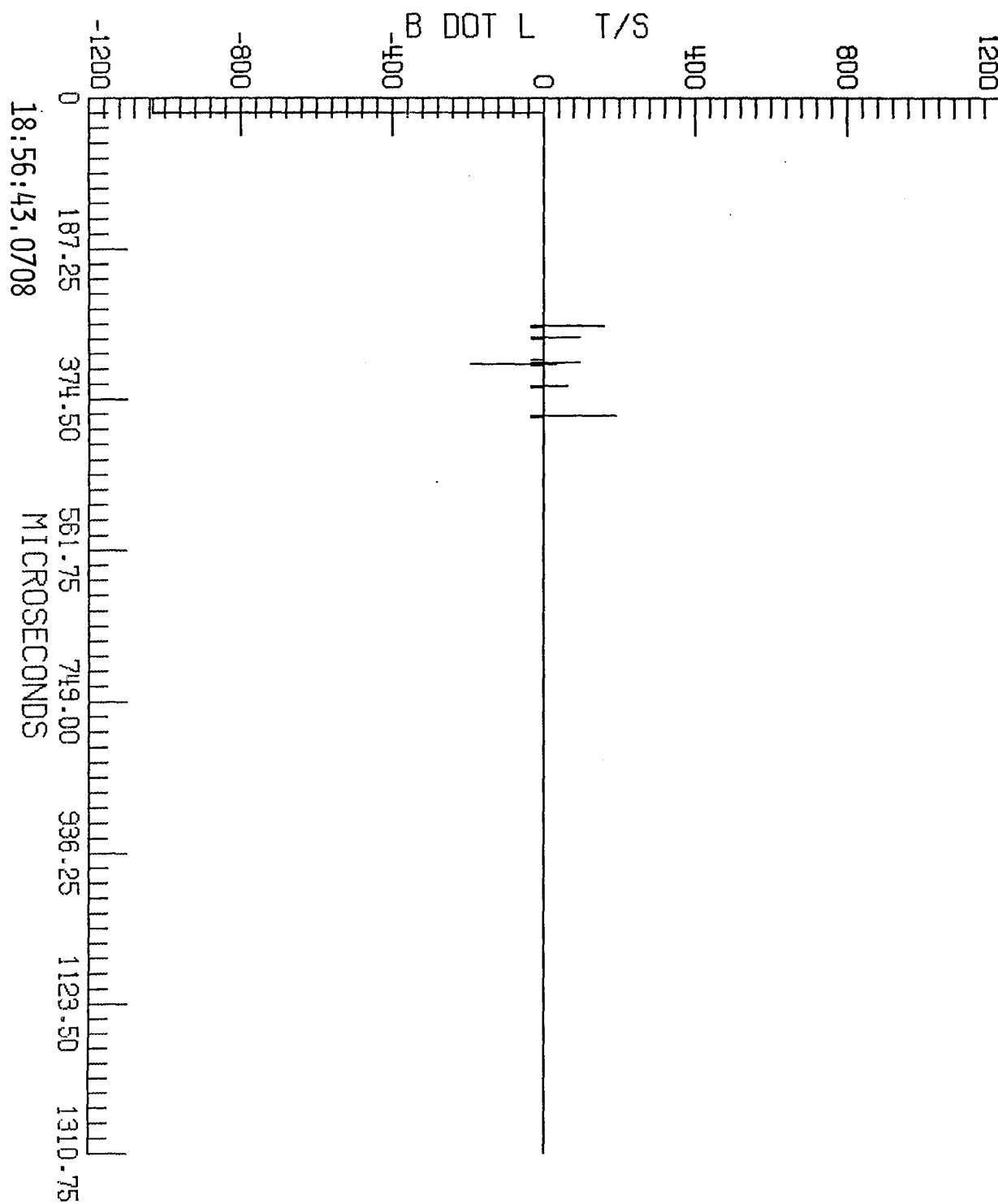
RUN NO. 1 S-001



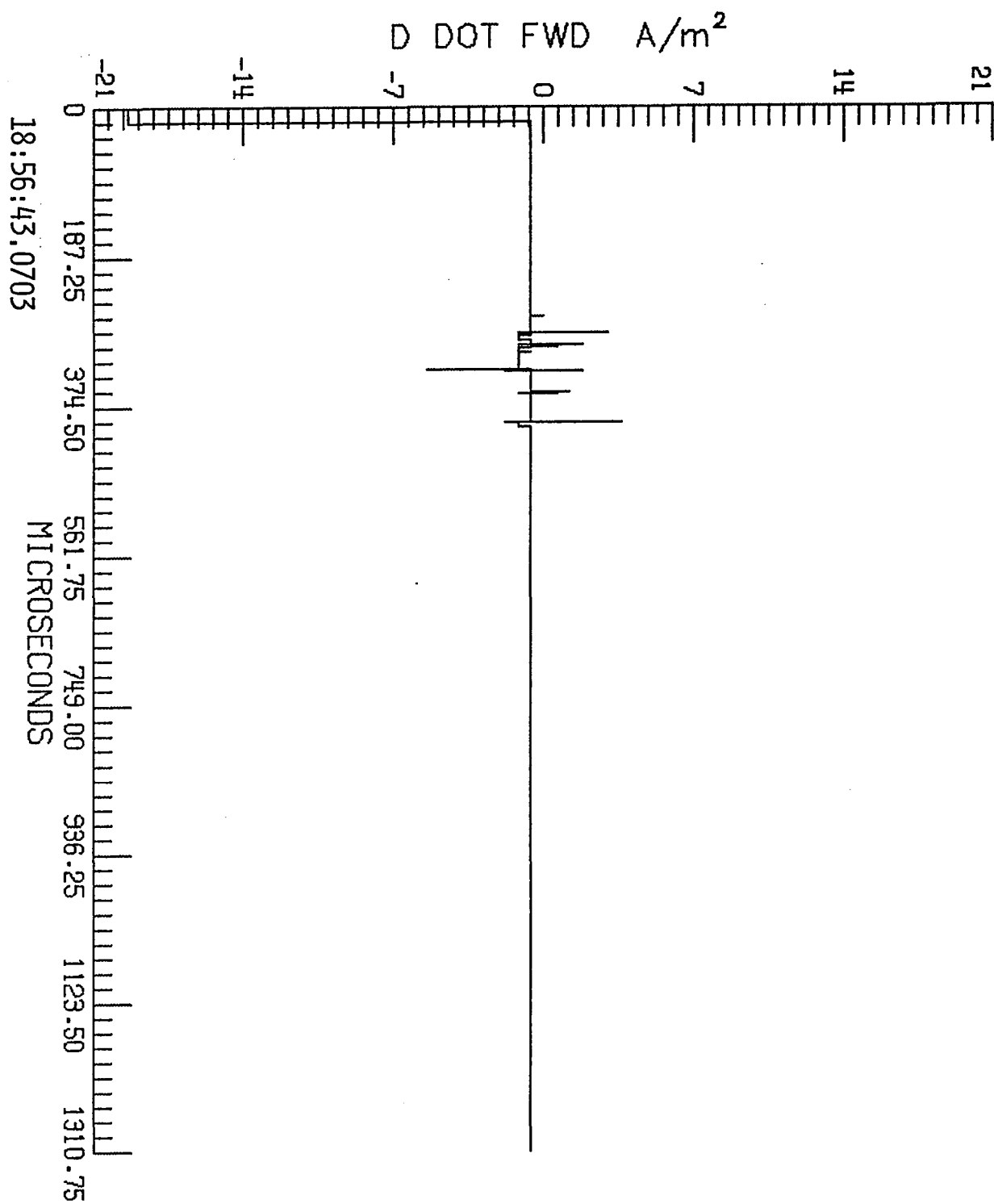
F106 LIGHTNING/TK-8/M.THOMAS

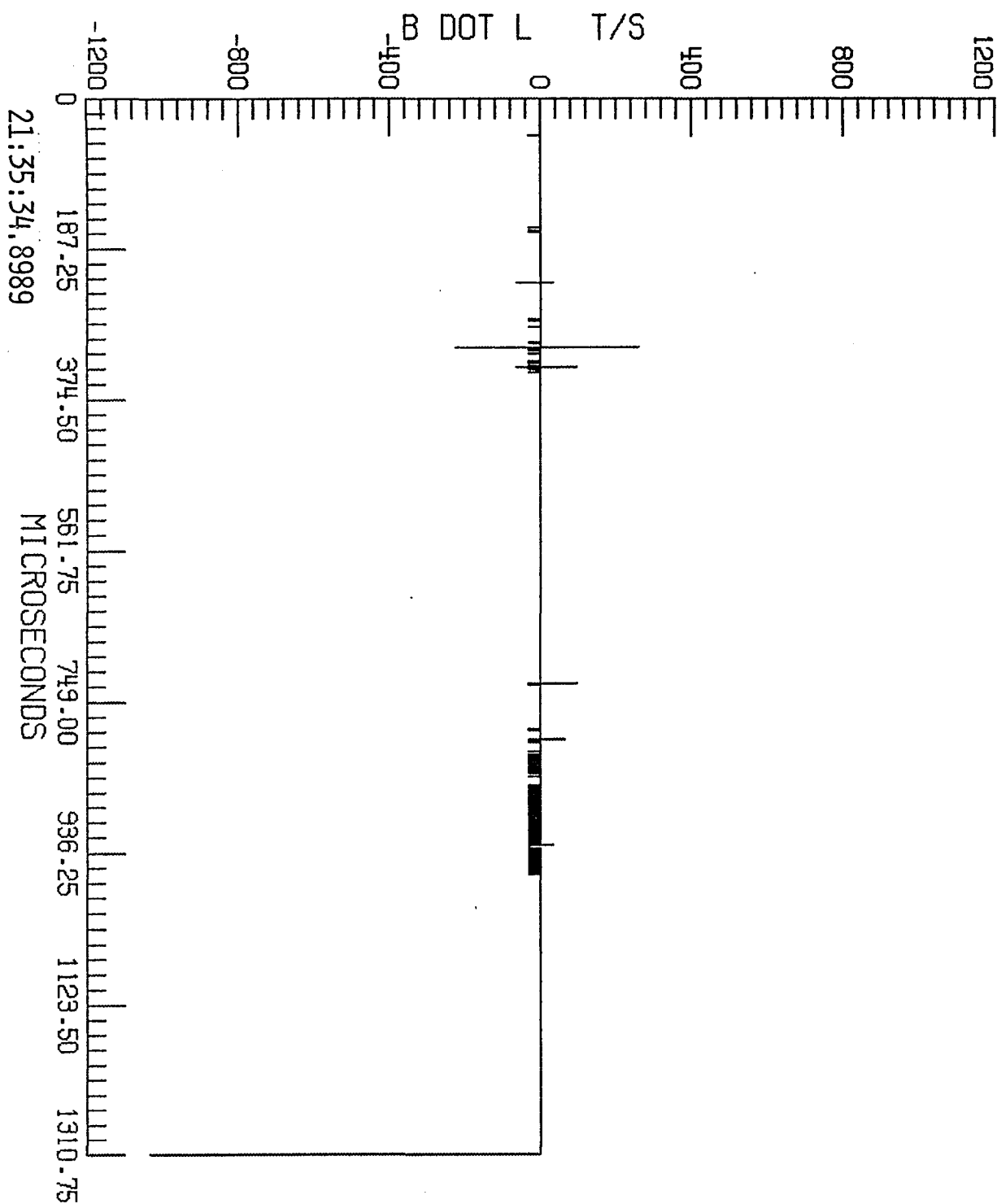
TEST NO. 83-

RUN NO. 2 S-002



RUN NO. 2 S-002

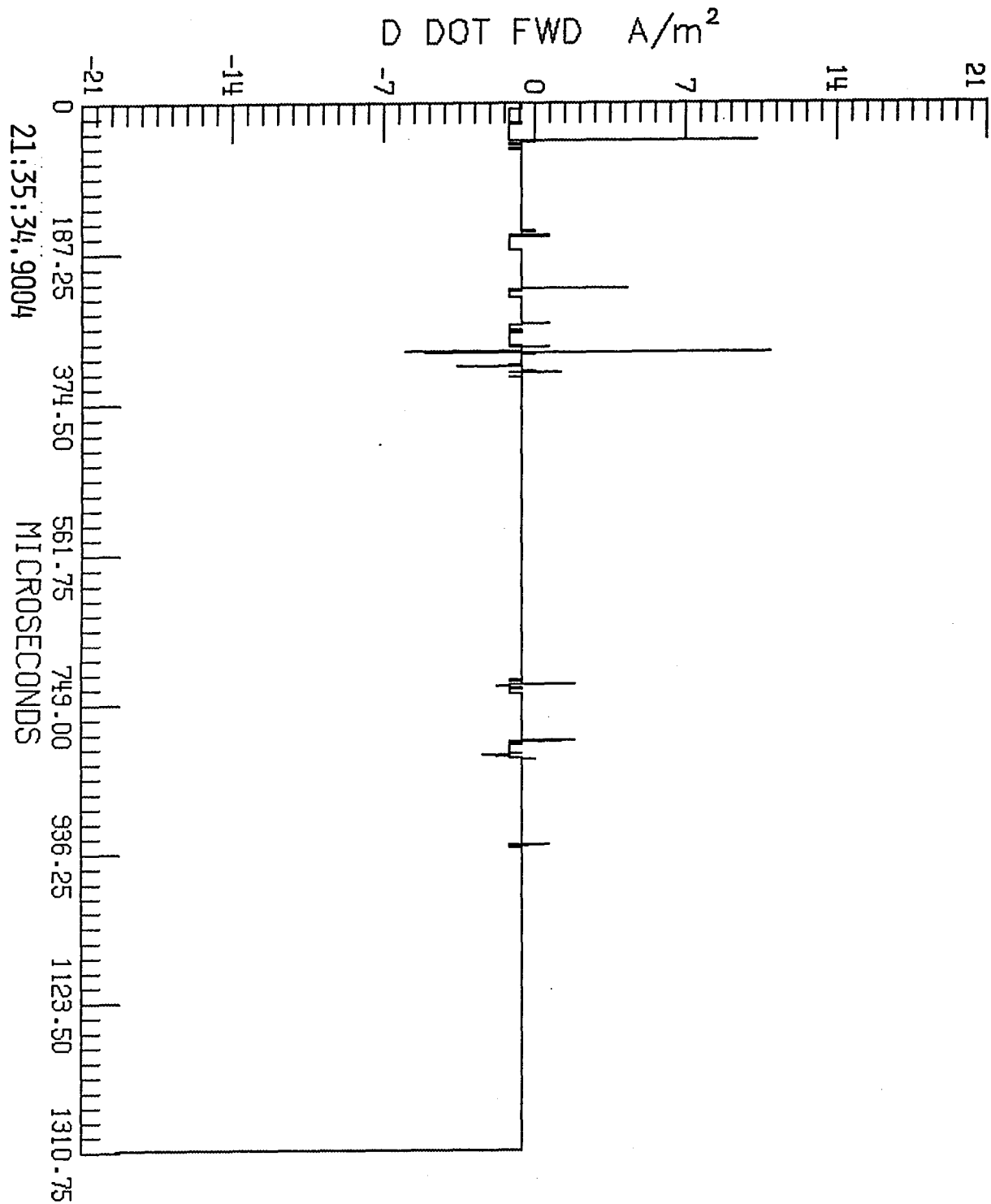




F106 LIGHTNINMG/TK-10/M.THOMAS
RUN NO.1

TEST NO. 83-

N-001



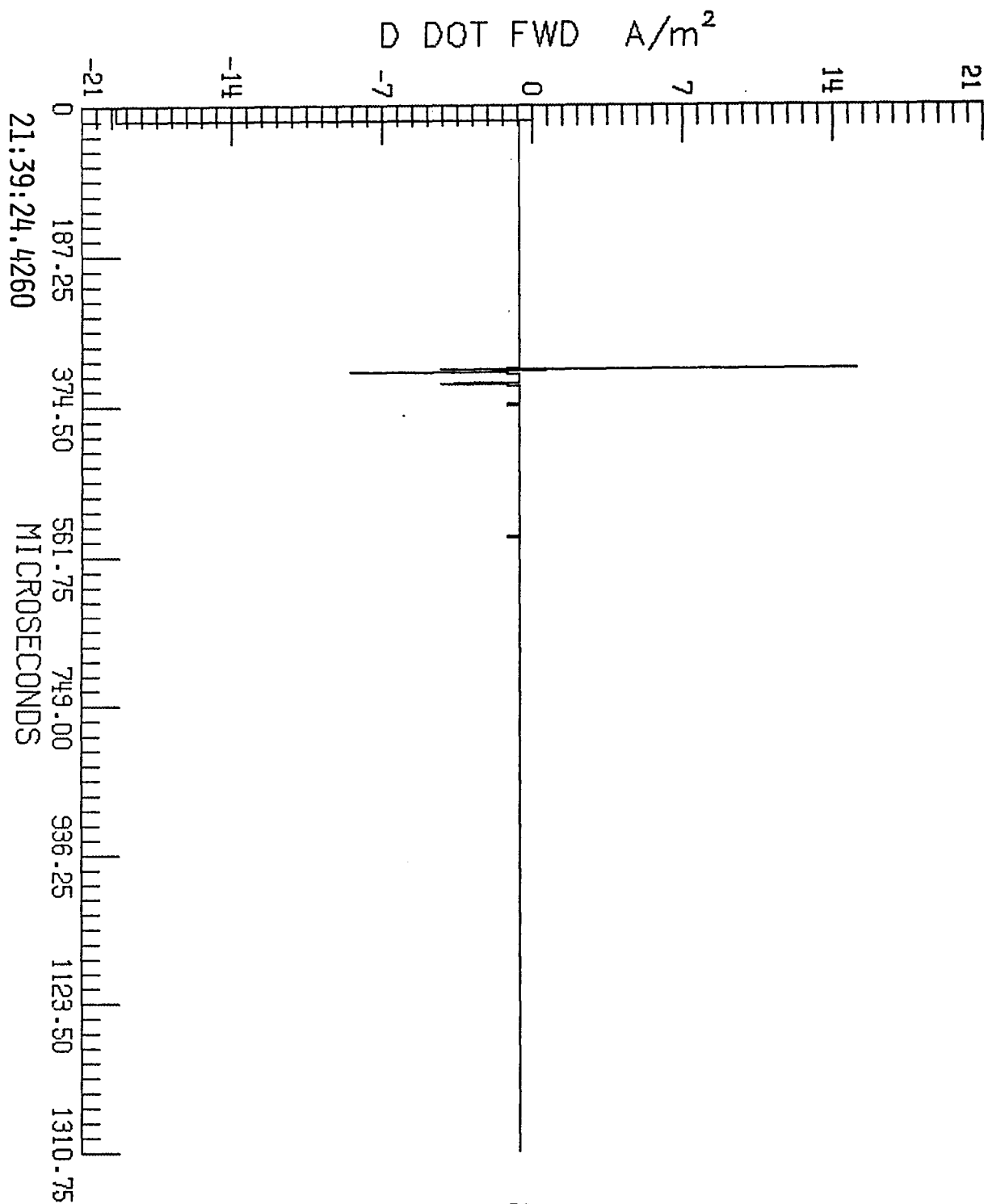
N-002



F106 LIGHTNINMG/TK-10/M.THOMAS
RUN NO. 2

N-002

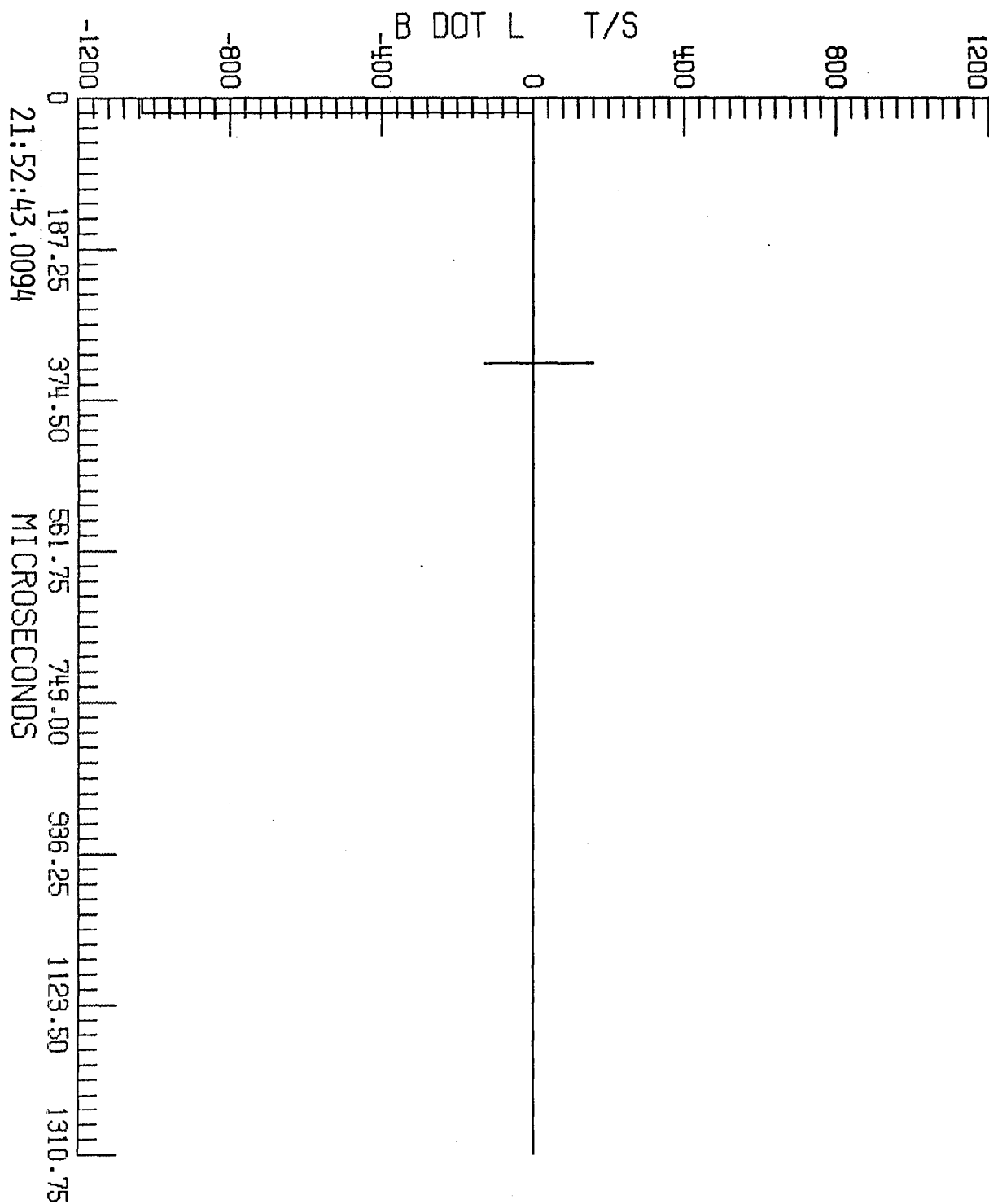
TEST NO. 83-



F106 LIGHTNING/TK-8/M.THOMAS
RUN NO. 3

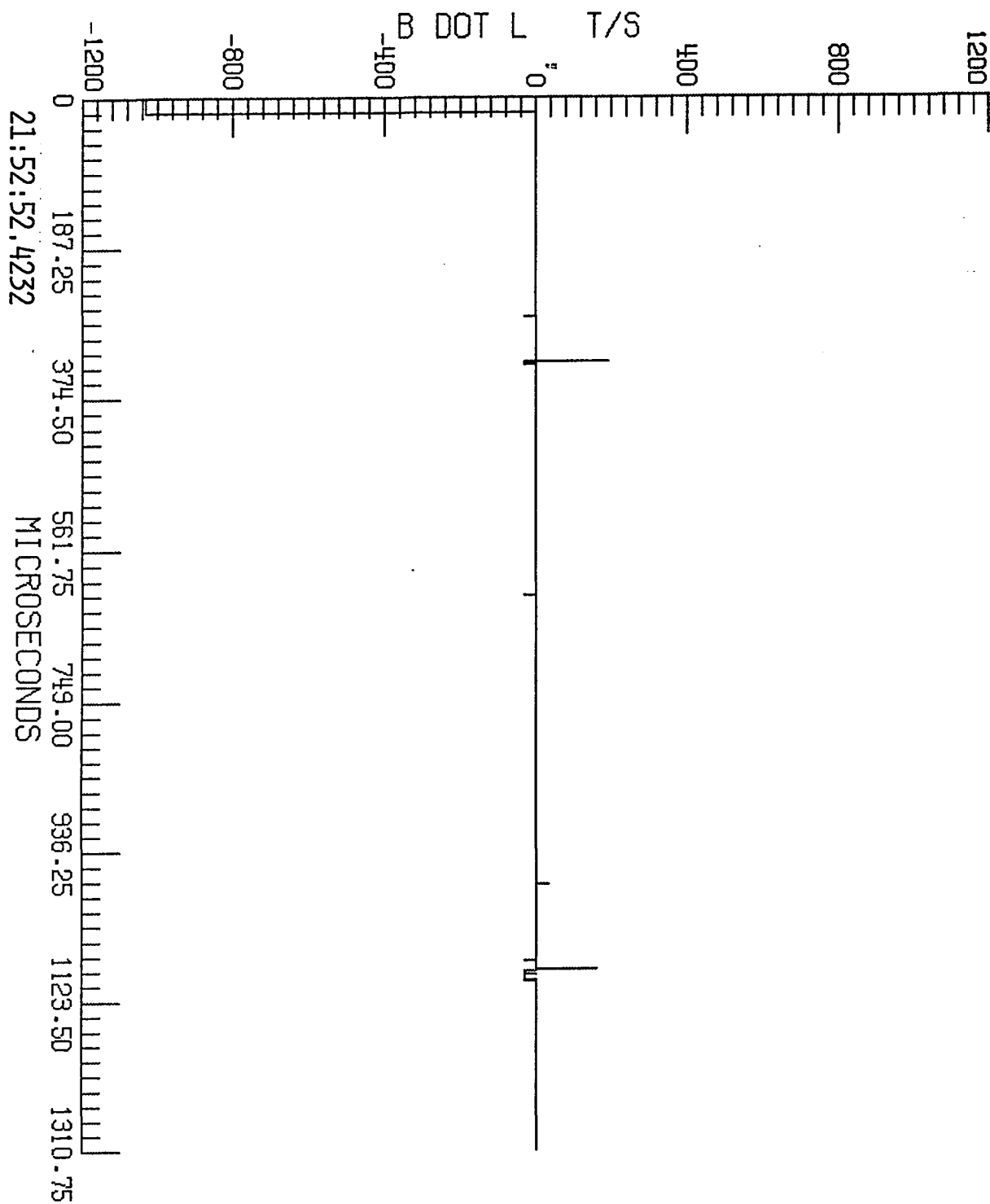
N-003

TEST NO. 83-



F106 LIGHTNING/TK-8/M.THOMAS
RUN NO. 4

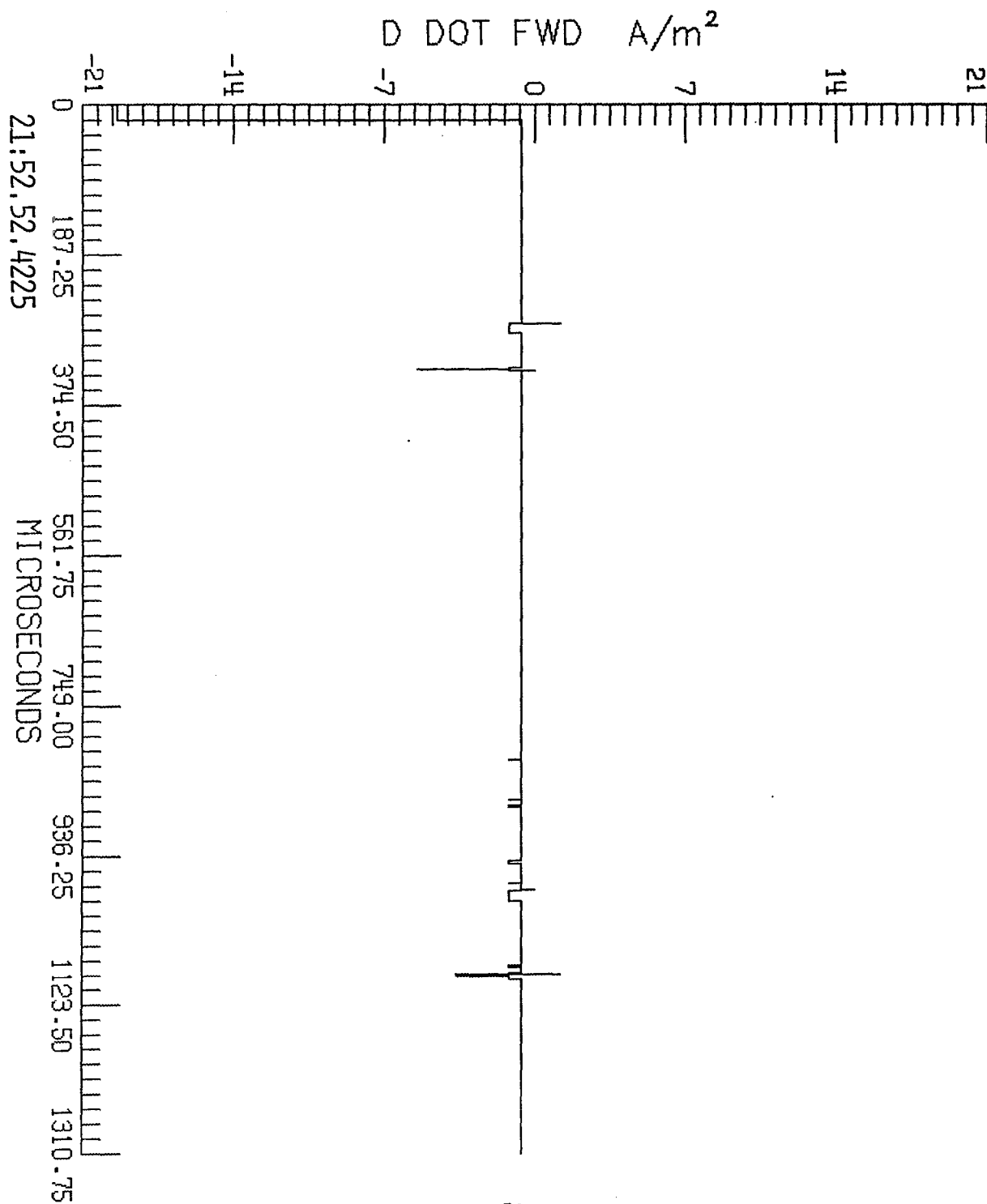
TEST NO. 83-



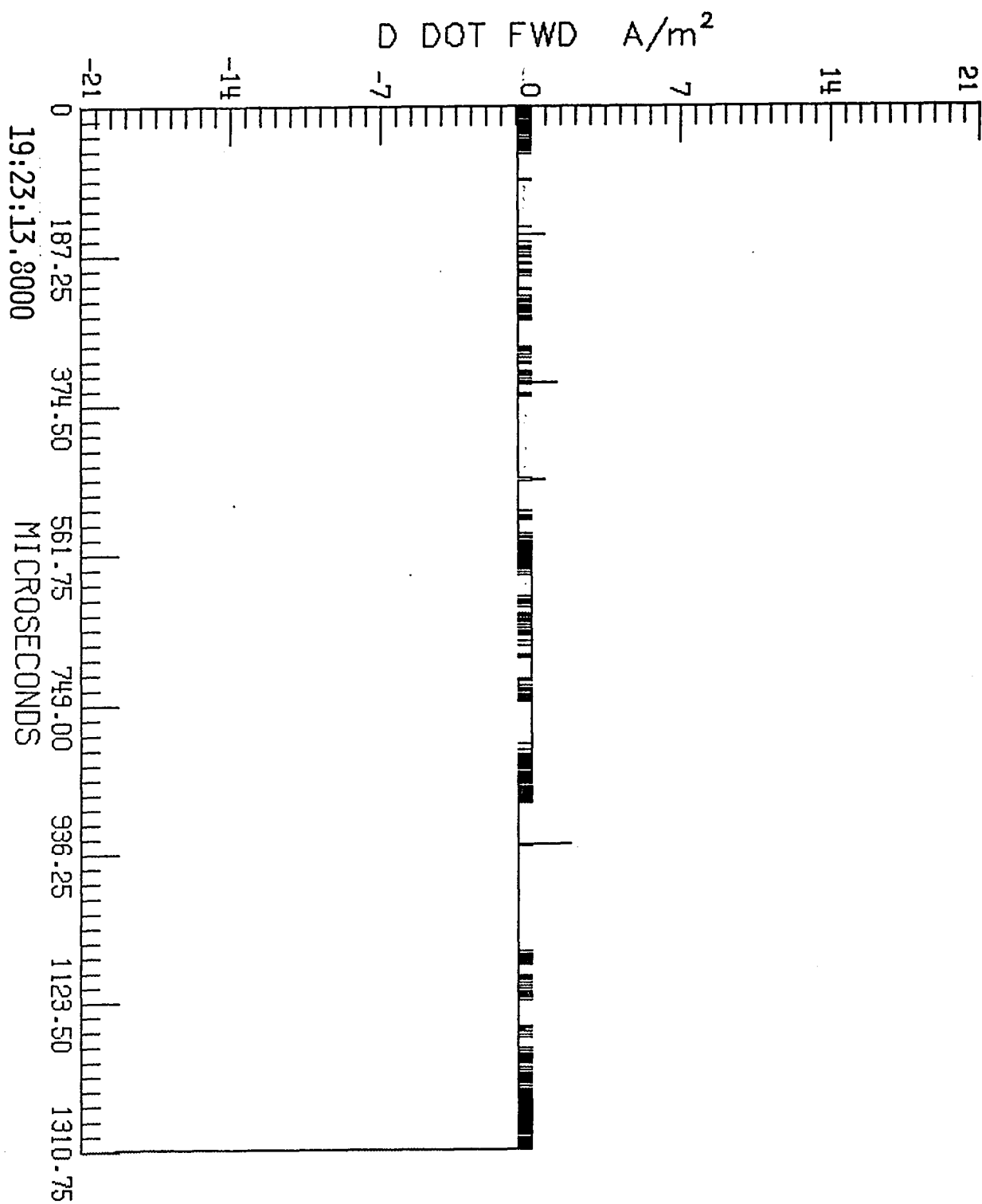
F106 LIGHTNINMG/TK-10/M.THOMAS
RUN NO. 4

TEST NO. 83-

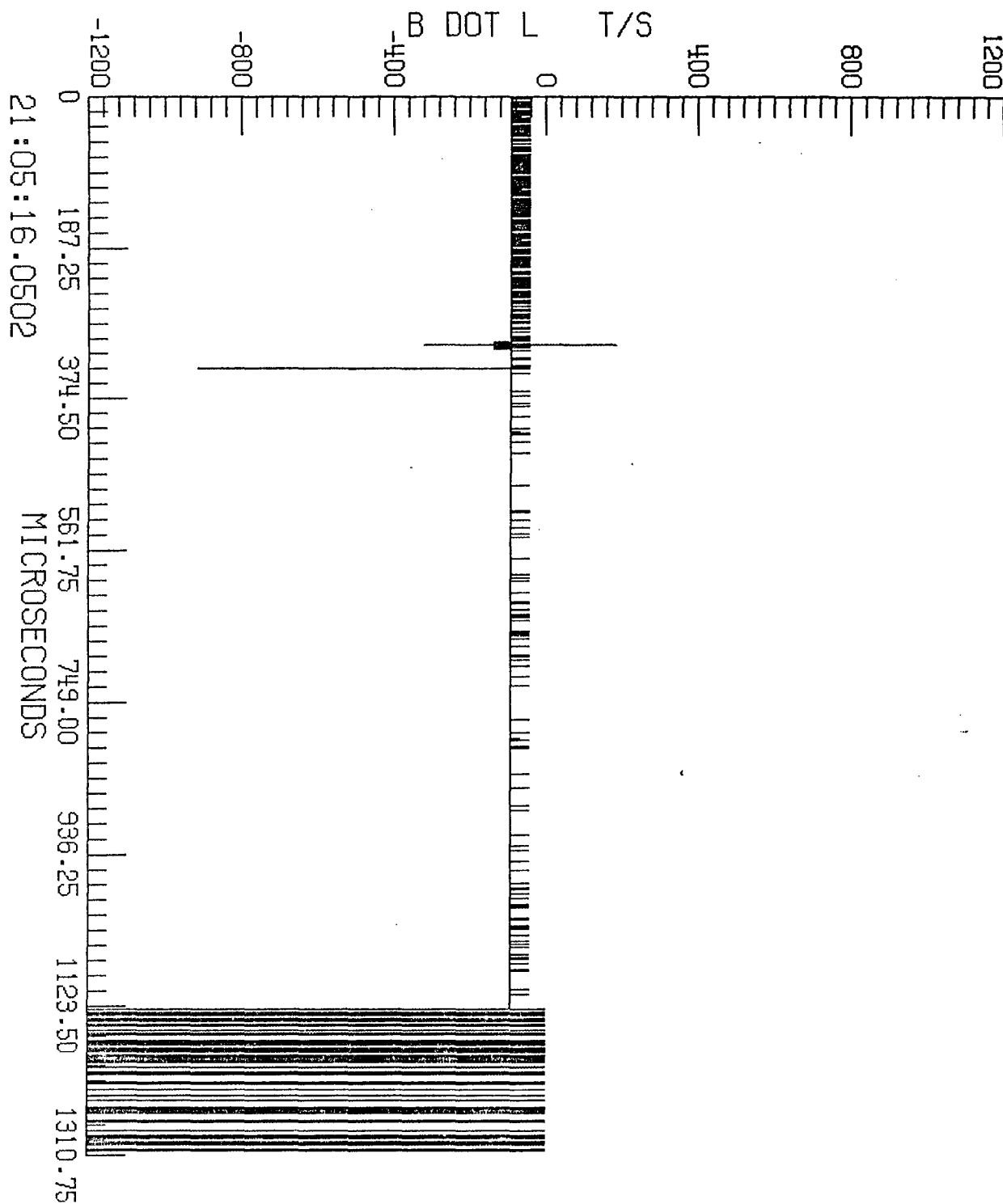
N-004



RUN NO. 1 S-001



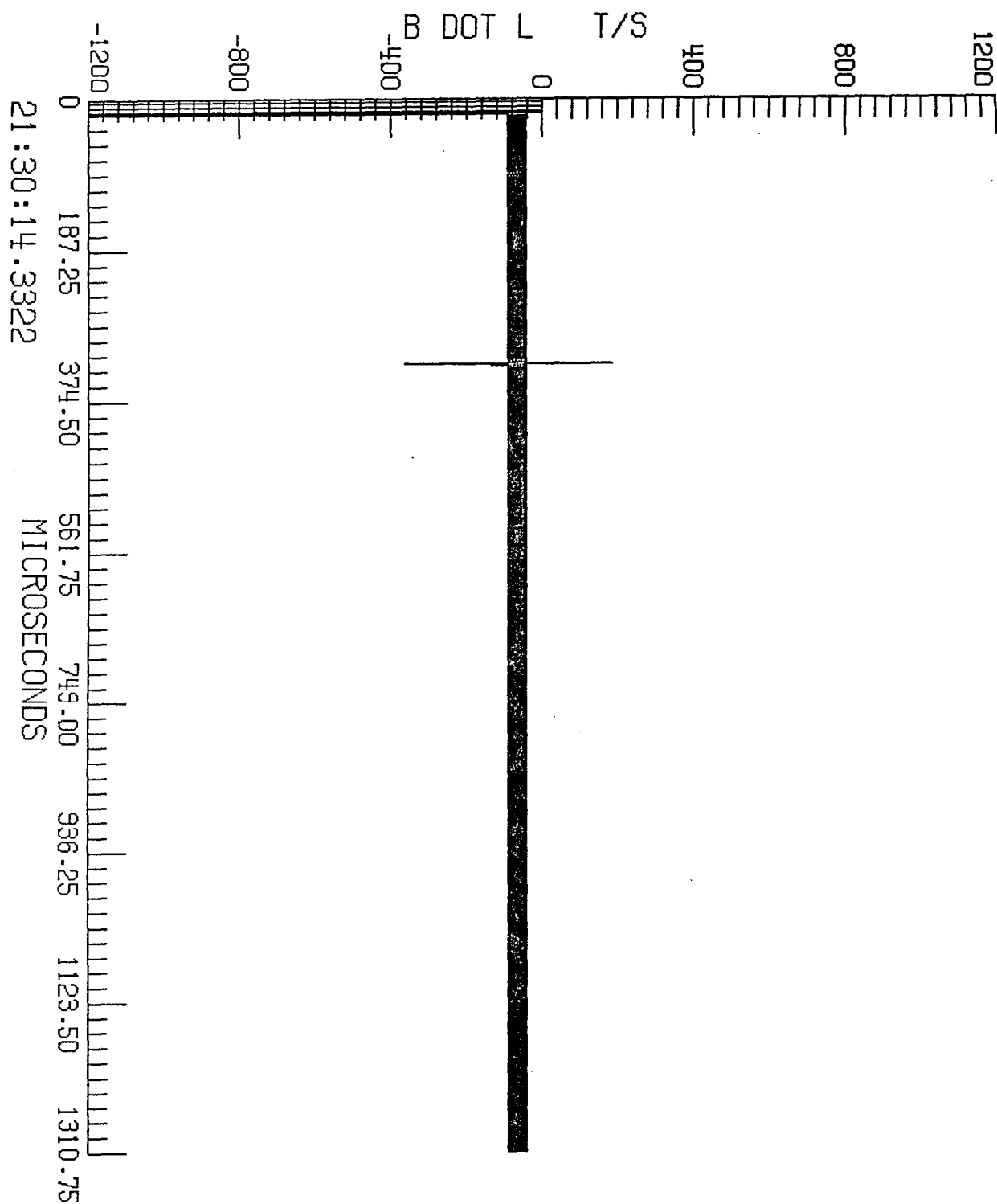
RUN NO. 1 N-001



F-106 LIGHTNING/TK.10/THOMAS

TEST NO. 83-0

RUN NO. 2 N-002

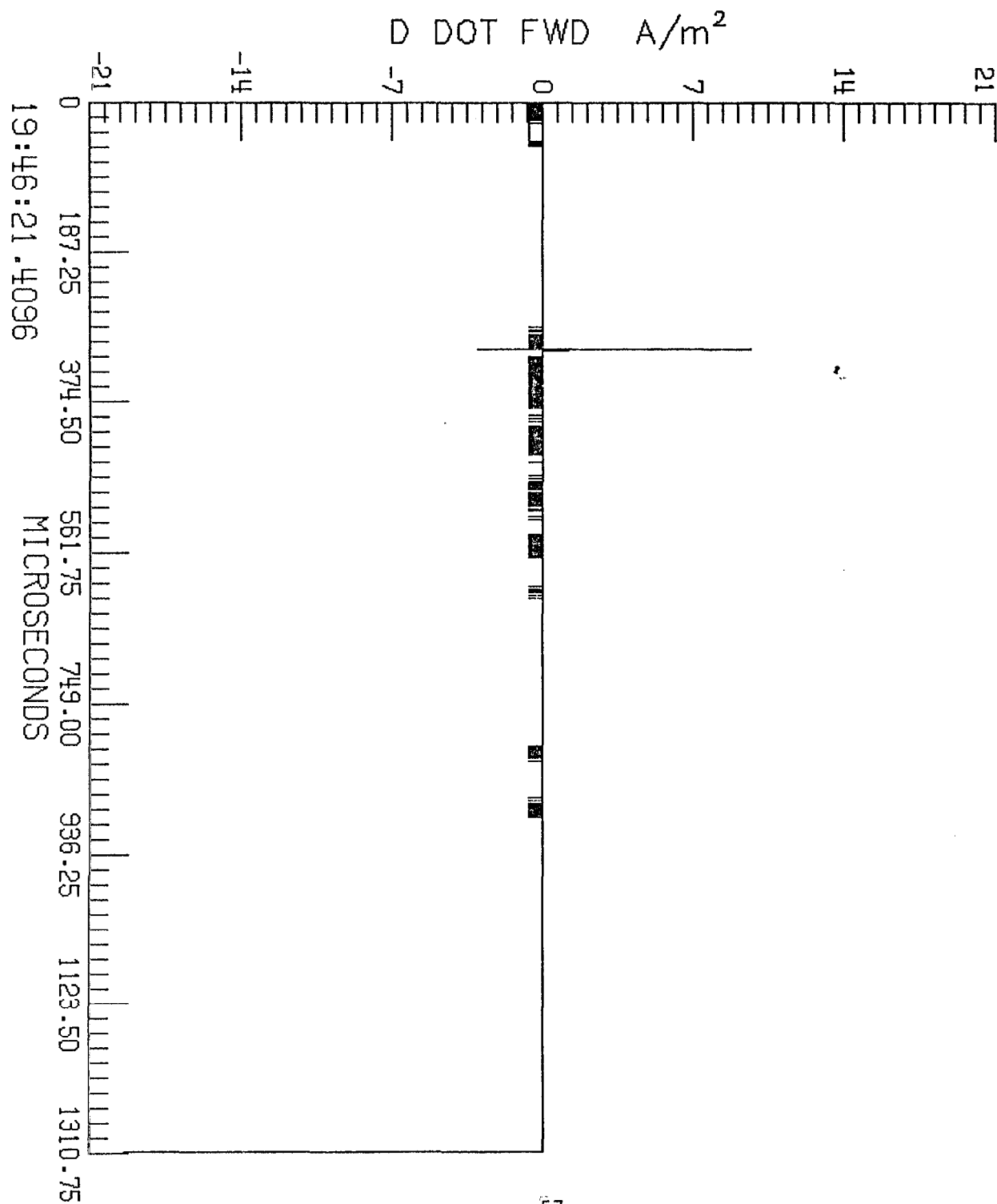


F-106 LIGHTNING/TK.8/THOMAS

TEST NO. 83

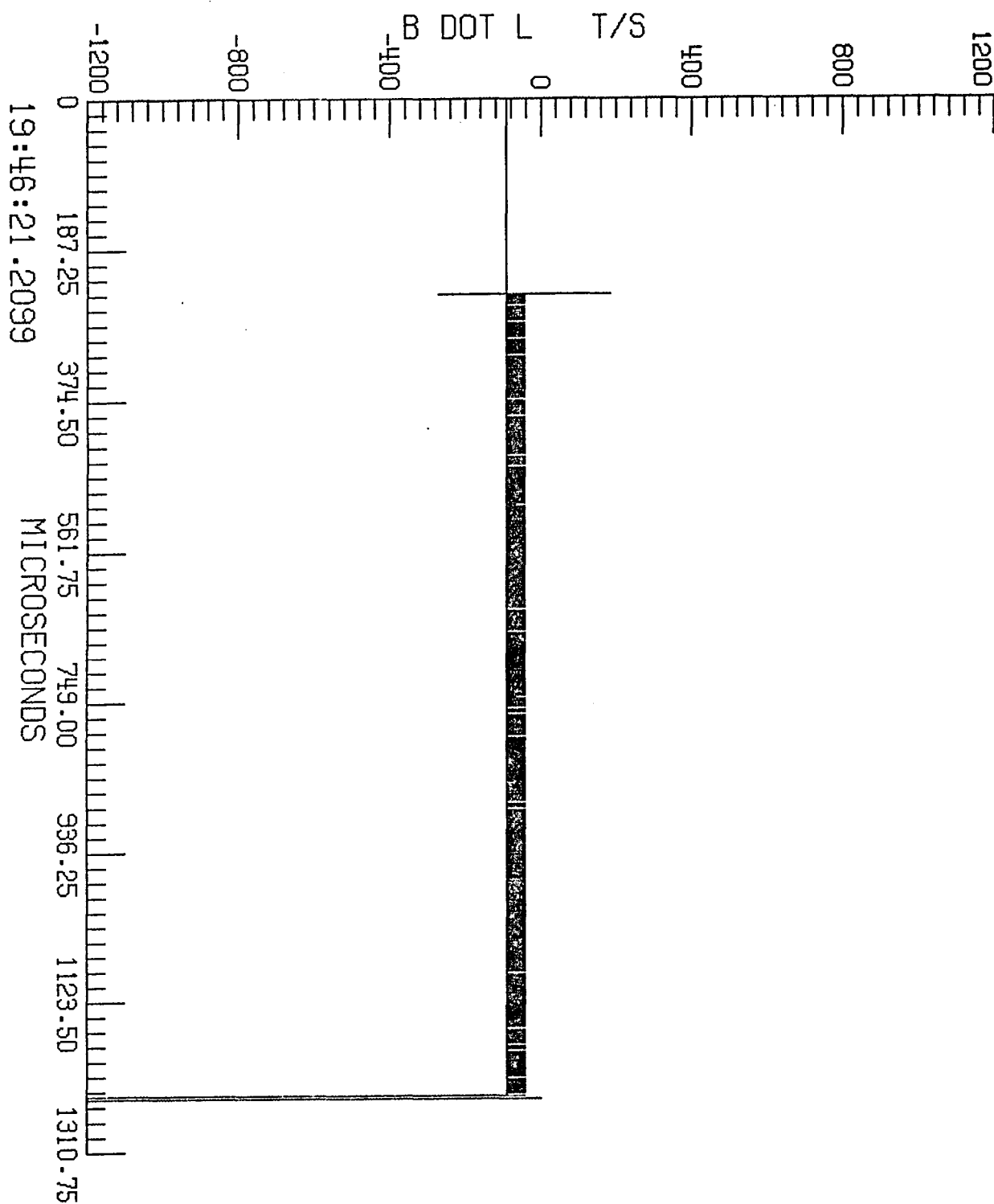
RUN NO. 1

S-001



F-106 LIGHTNING/TK.10/THOMAS
RUN NO. 1 S-001

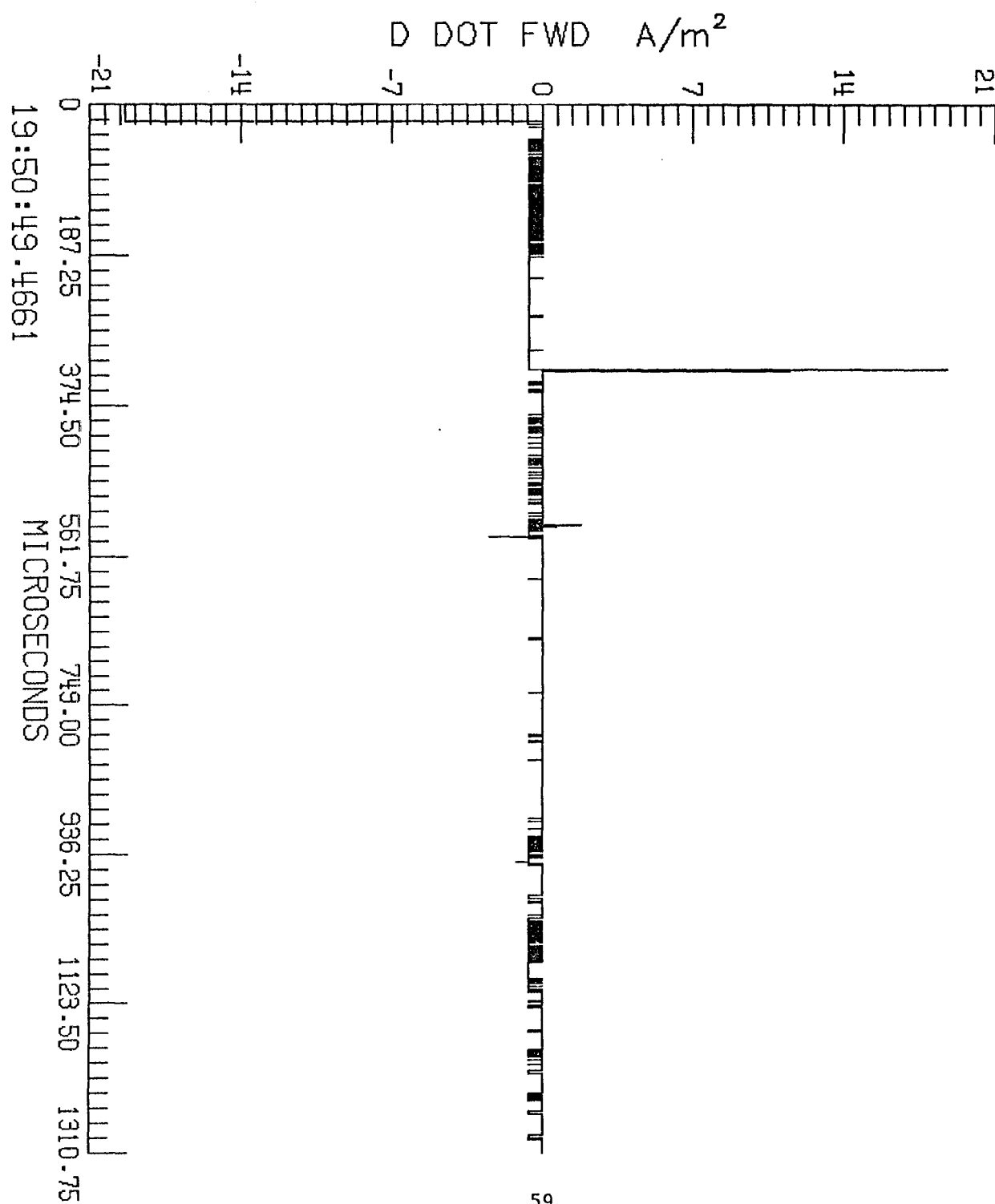
TEST NO. 83-



F-106 LIGHTNING/TK.8/THOMAS
RUN NO. 2

S-002

TEST NO. 83-

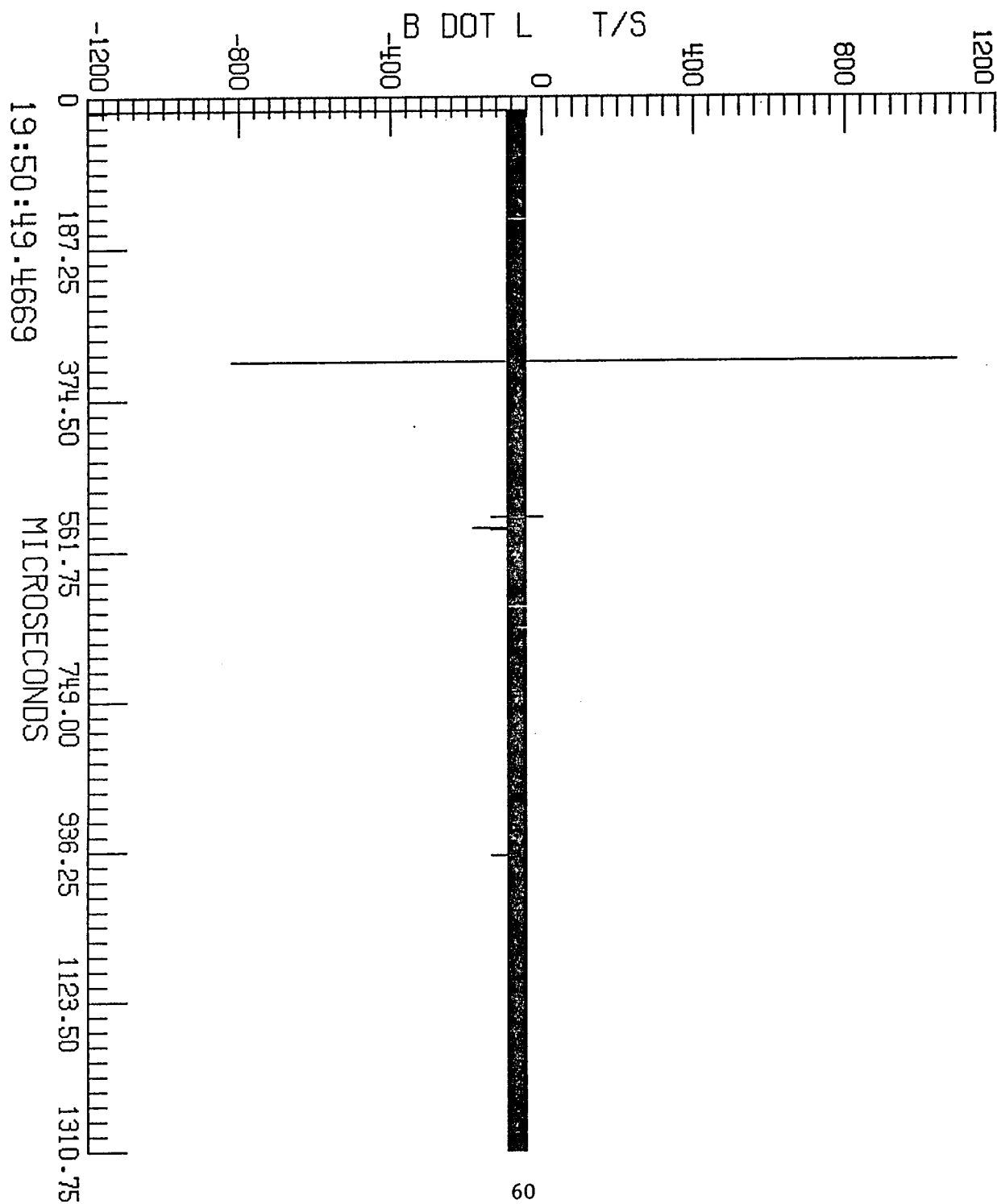


F-106 LIGHTNING/TK.10/THOMAS

TEST NO. 83-

RUN NO. 2

S-002

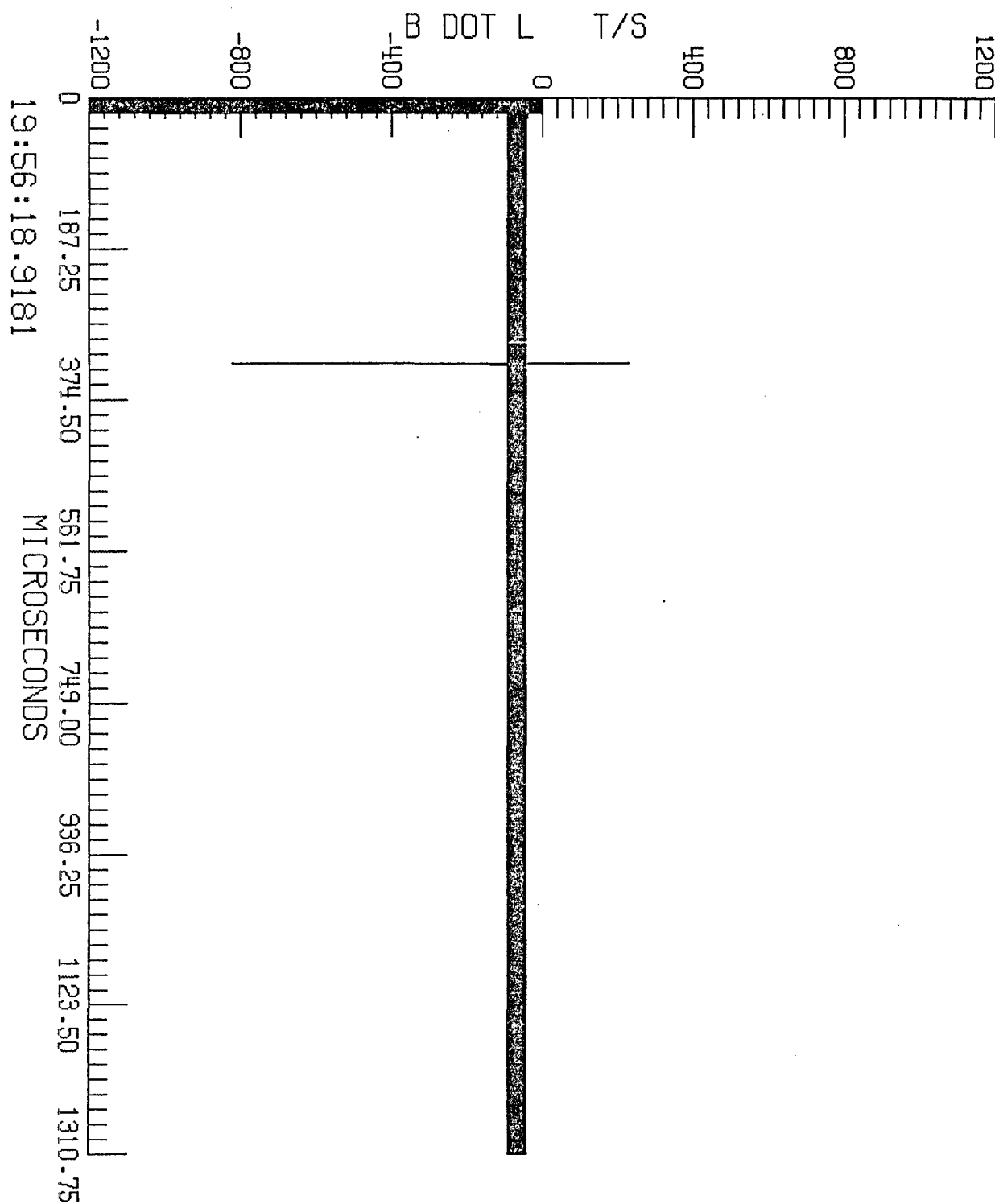


F-106 LIGHTNING/TK.10/THOMAS

TEST NO. 83-

RUN NO. 3

N-001

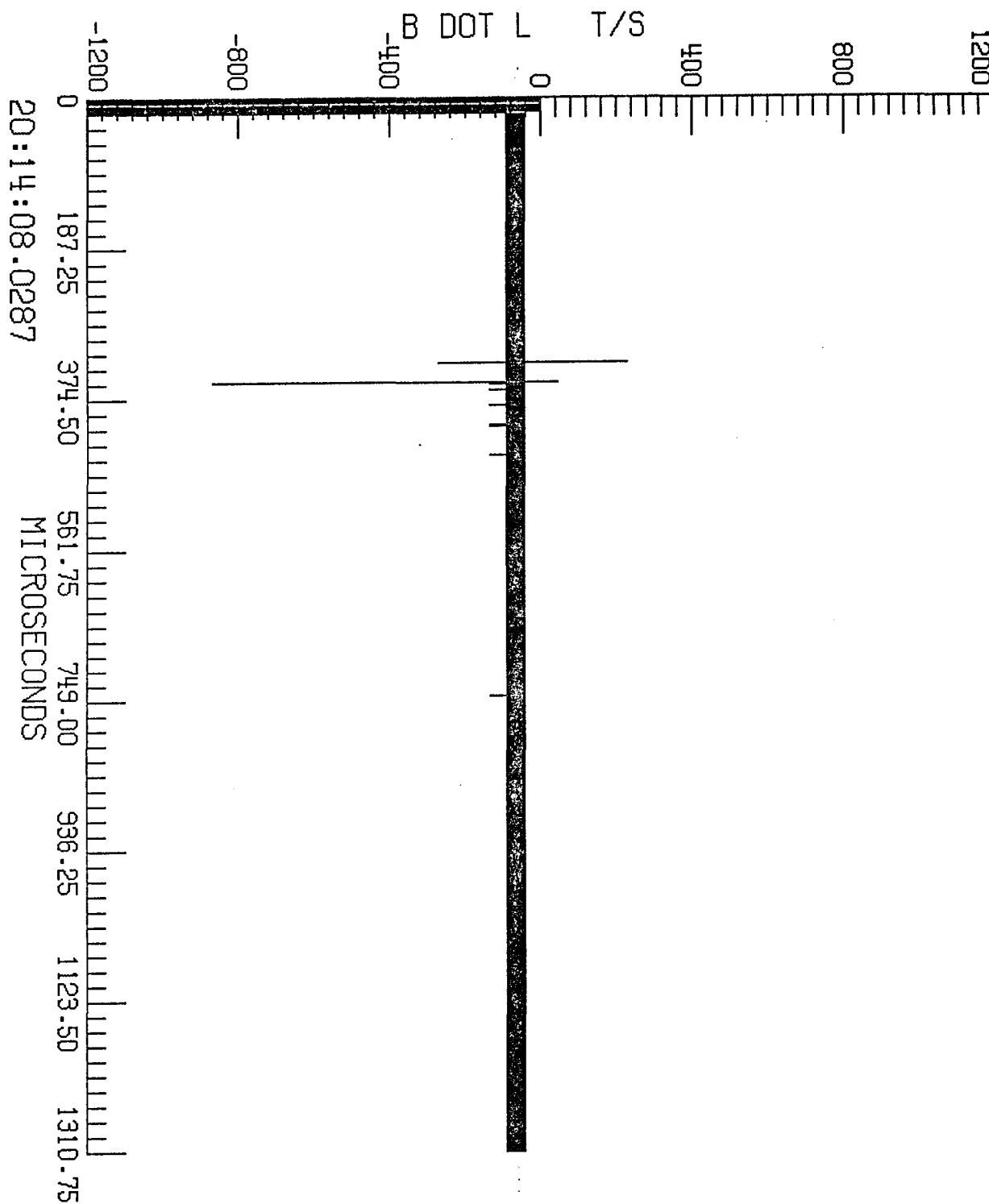


F-106 LIGHTNING/TK.10/THOMAS

TEST NO. 83-

RUN NO. 4

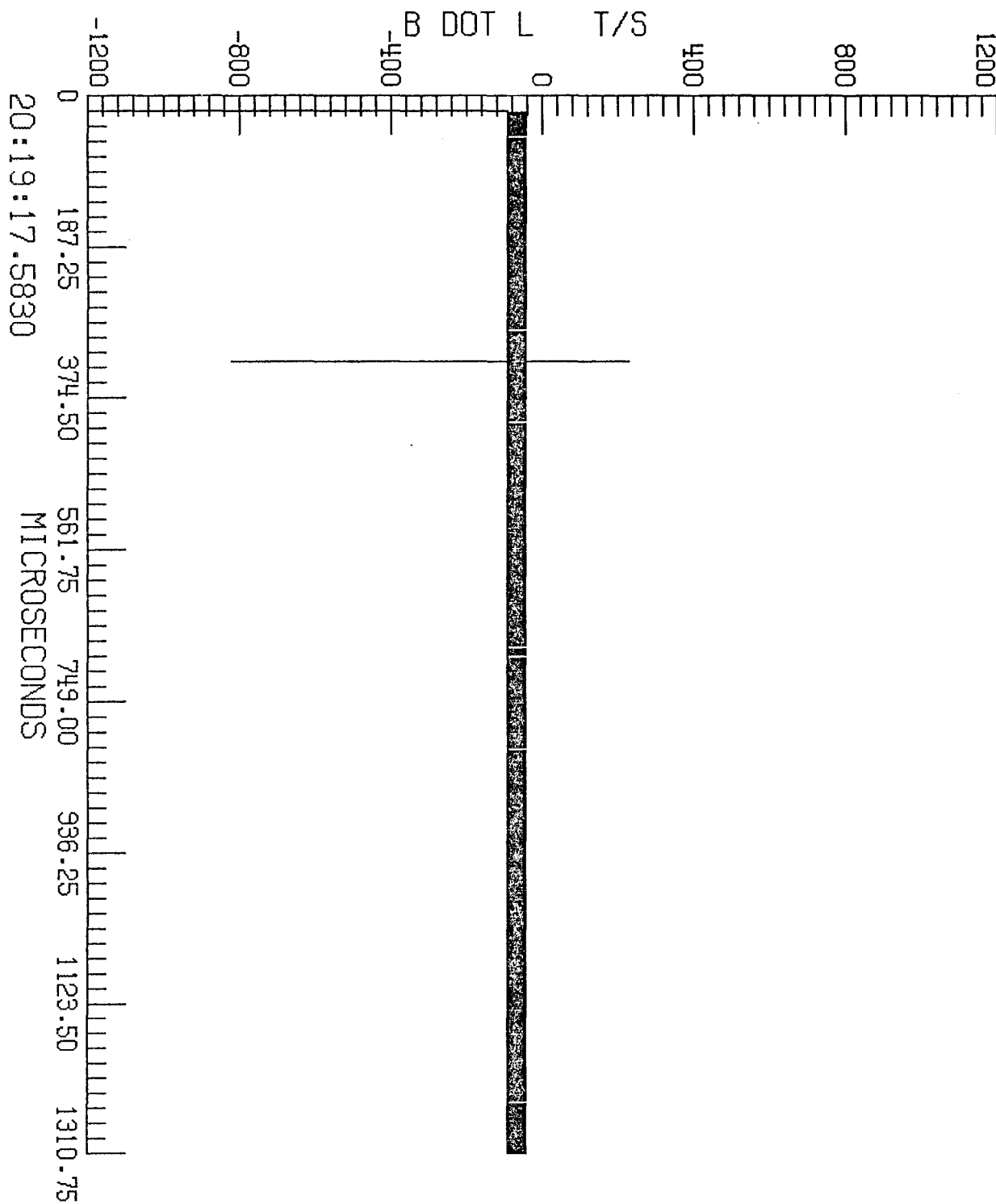
N-002



F-106 LIGHTNING/TK.10/THOMAS
RUN NO. 5

S-003

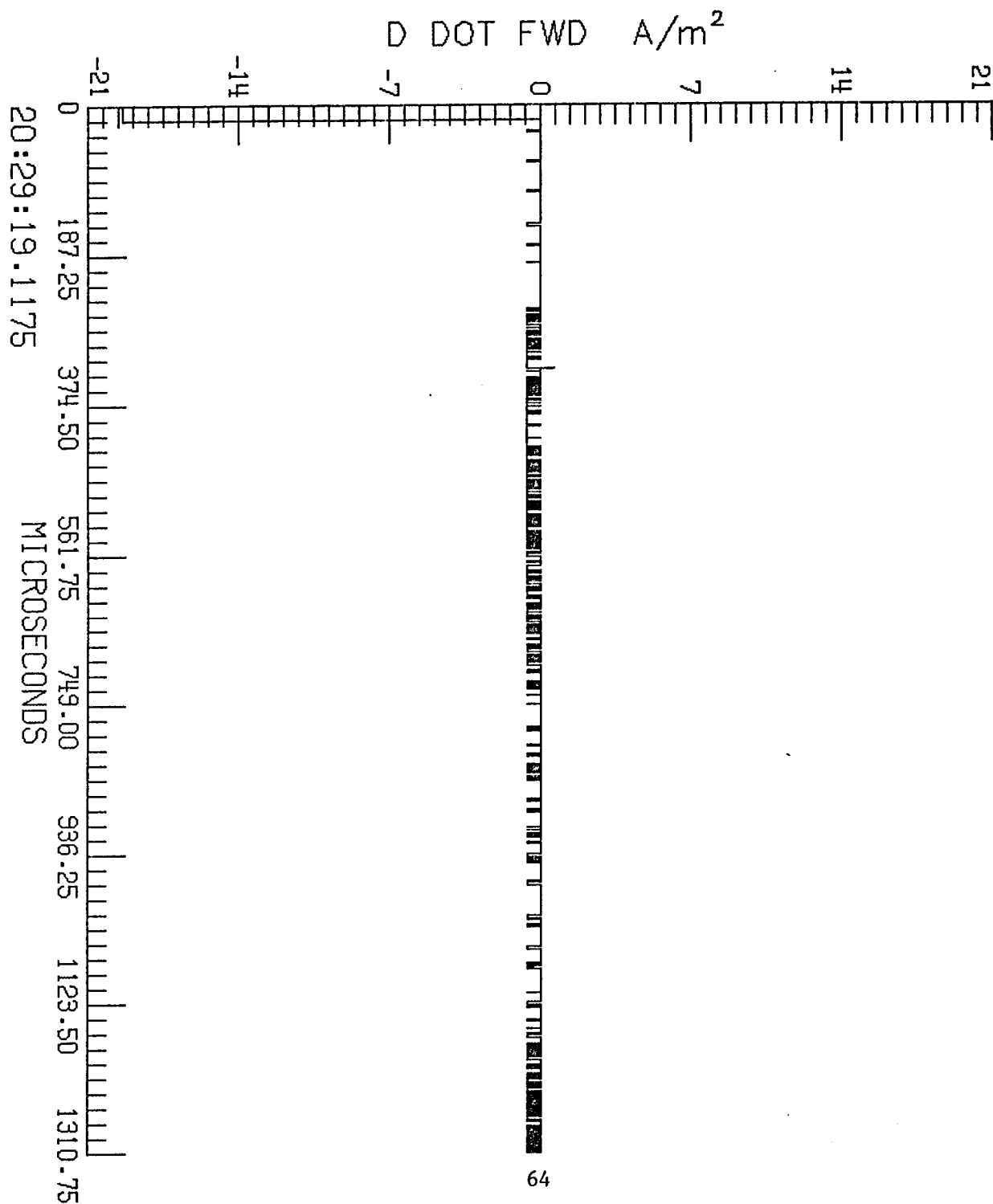
TEST NO. 83-



F-106 LIGHTNING/TK.8/THOMAS
RUN NO. 6

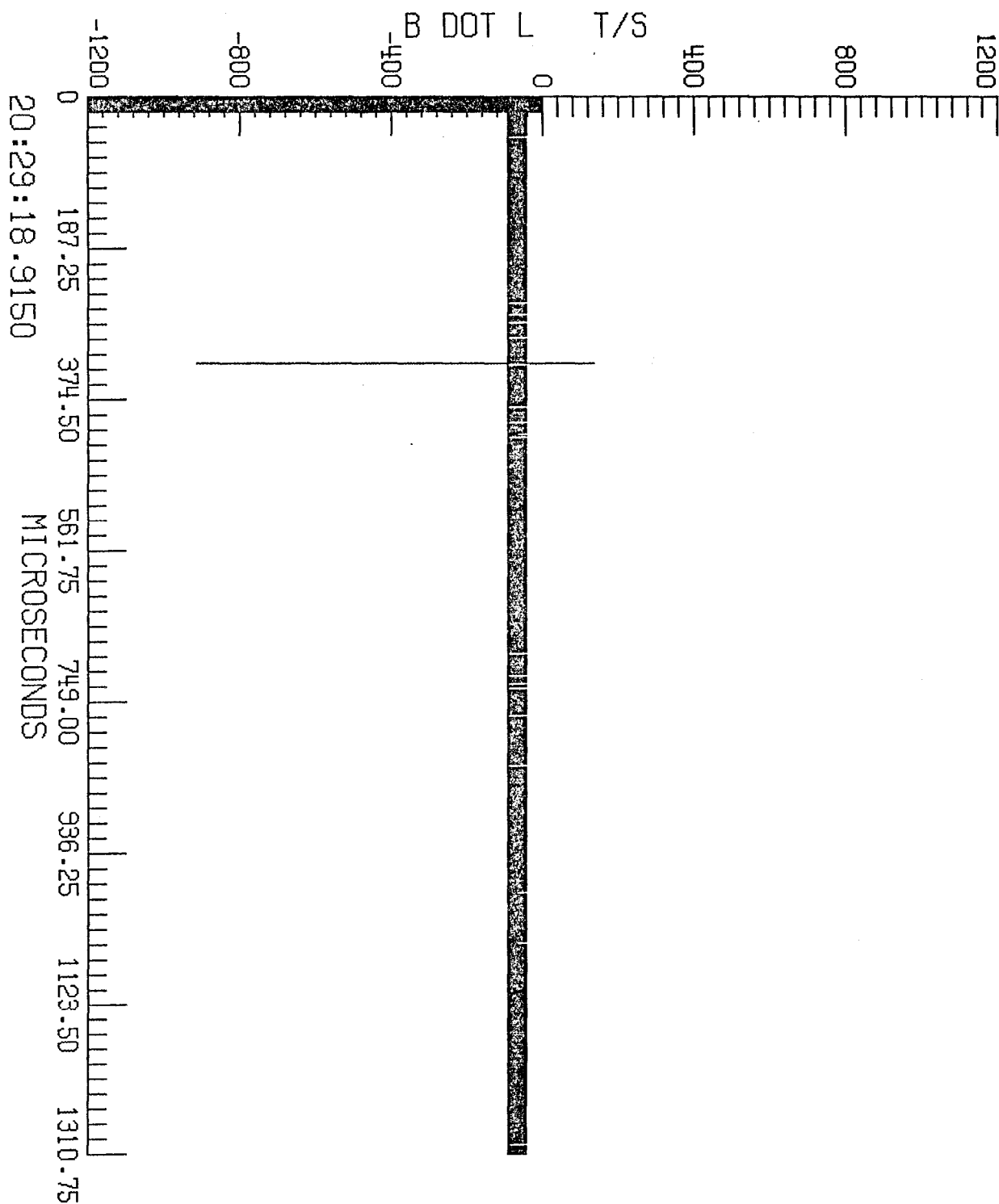
N-003

TEST NO. 83



F-106 LIGHTNING/TK.10/THOMAS
RUN NO. 6 N-003

TEST NO. 83-

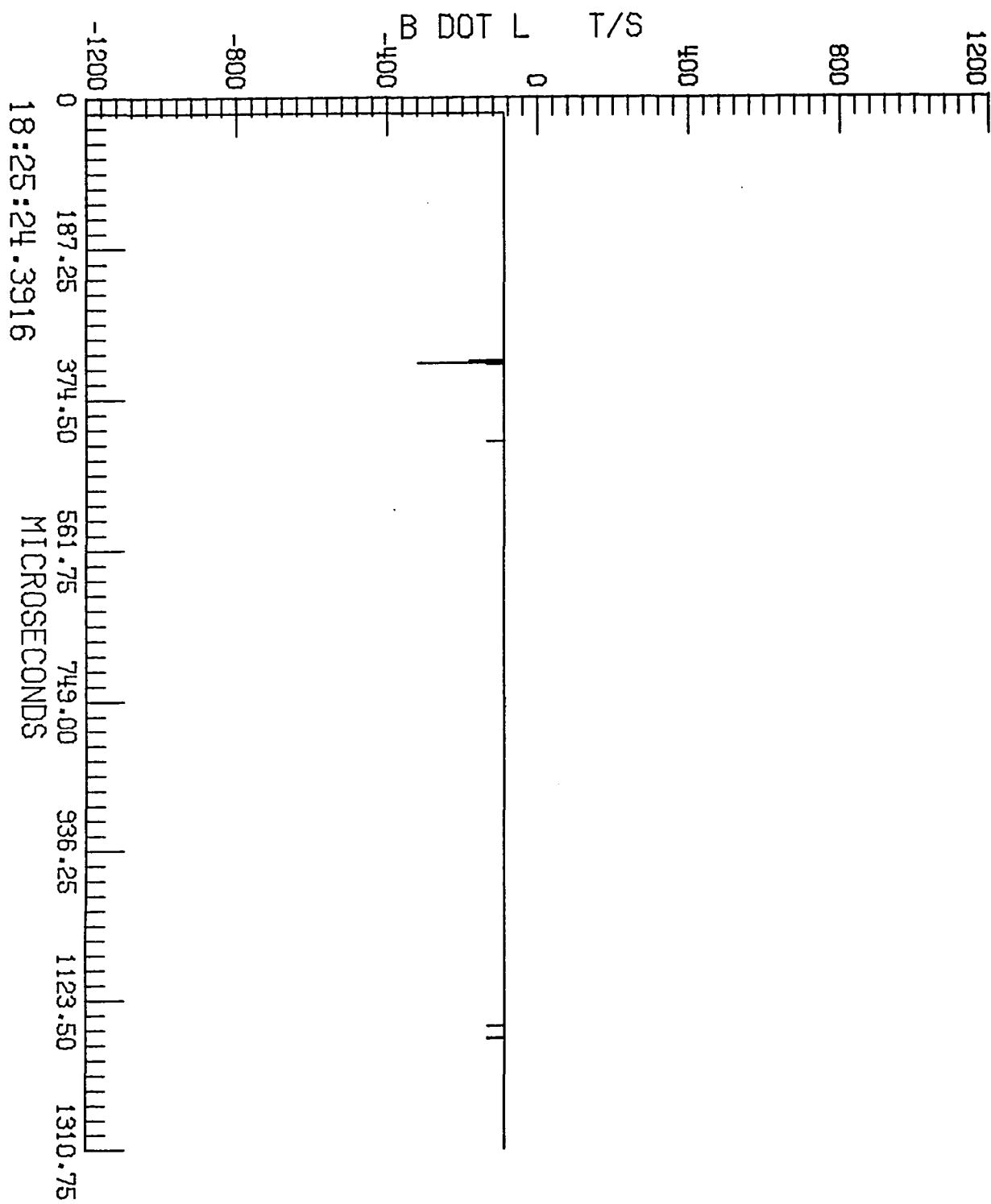


F106 LIGHTNING/TK.10/M.THOMAS

TEST NO. 83-021

RUN NO. 2

S-002

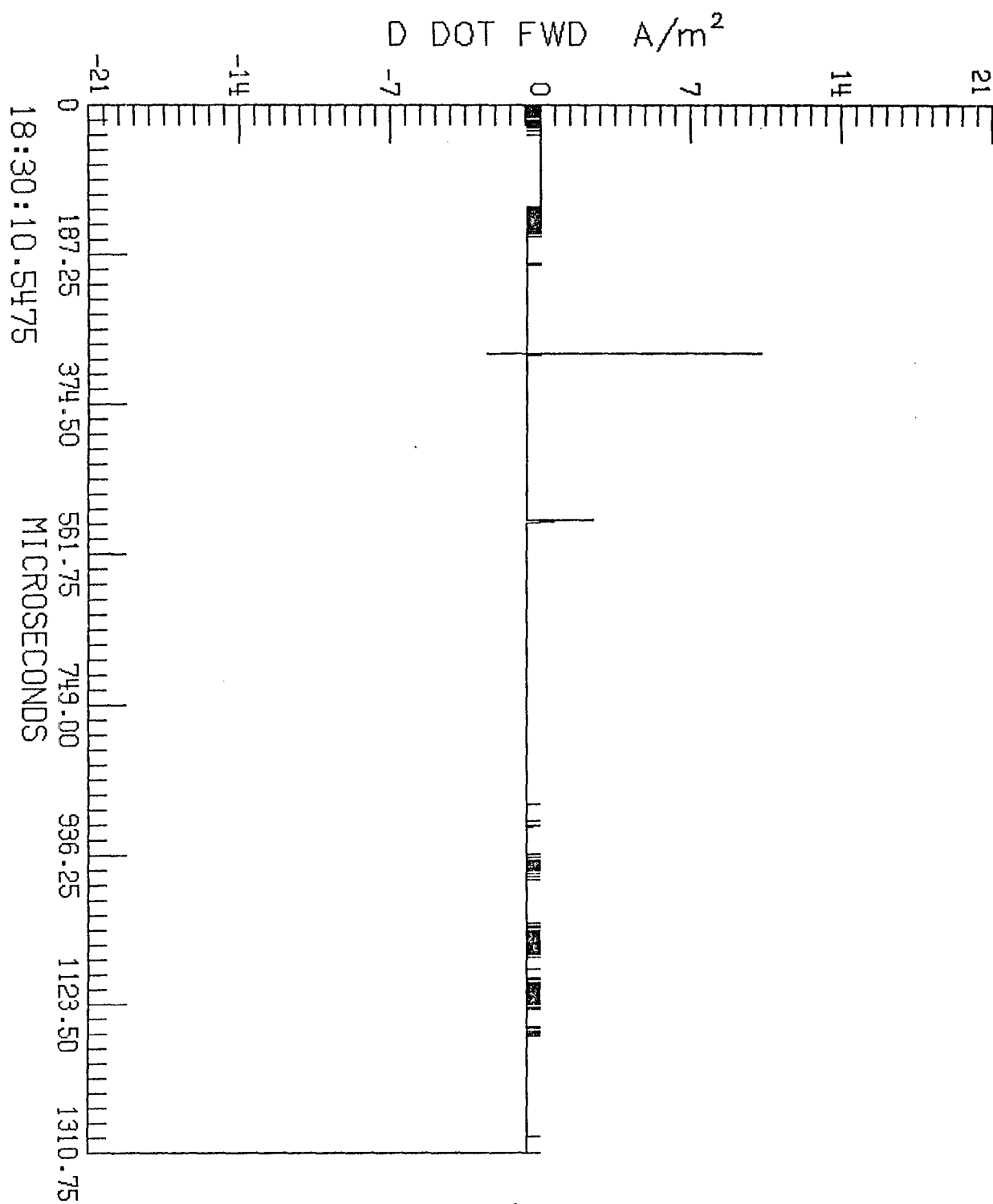


F106 LIGHTNING/TK.8/M.THOMAS

TEST NO. 83-

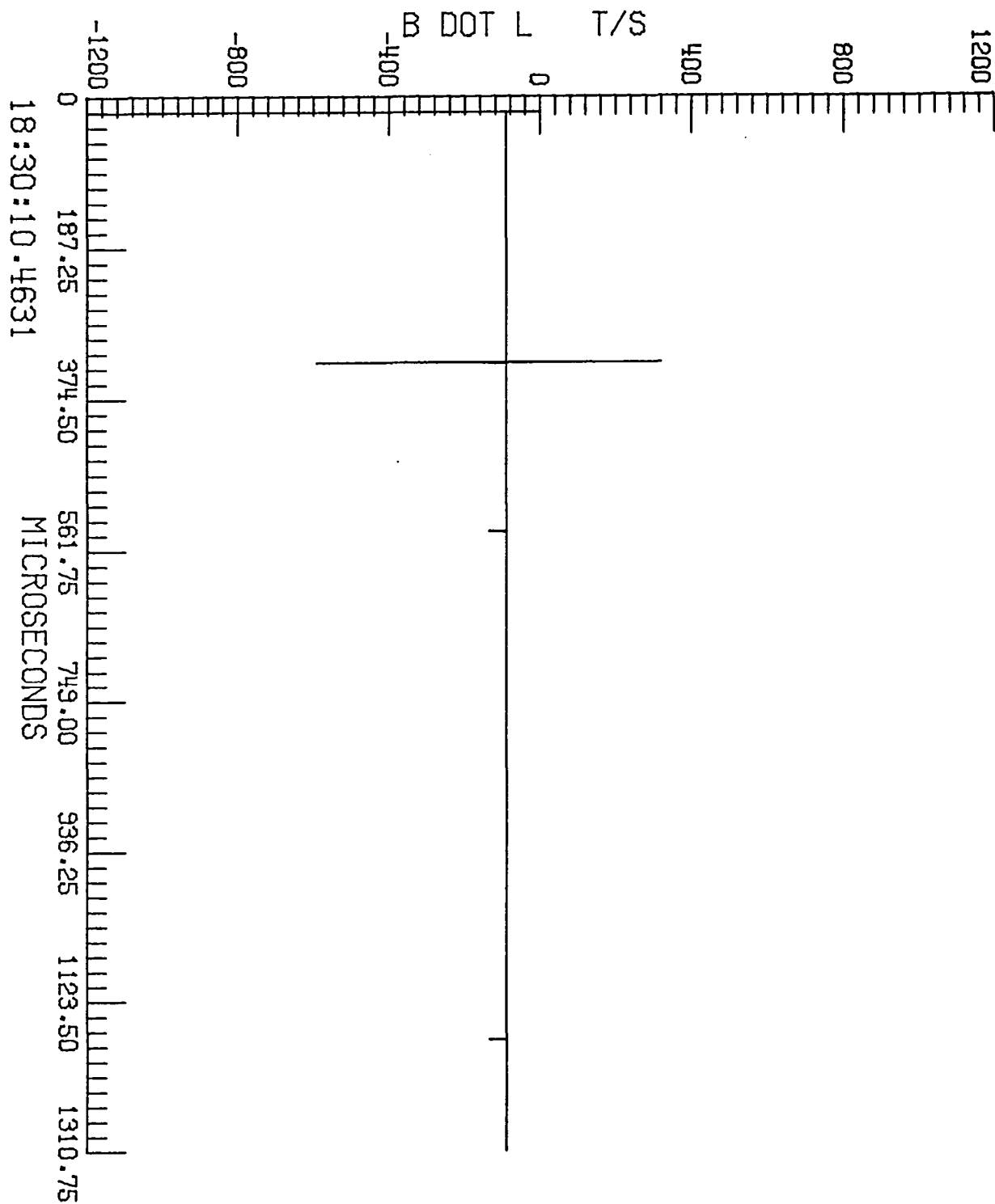
RUN NO. 3

S-003



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 3 S-003

TEST NO. 83-021

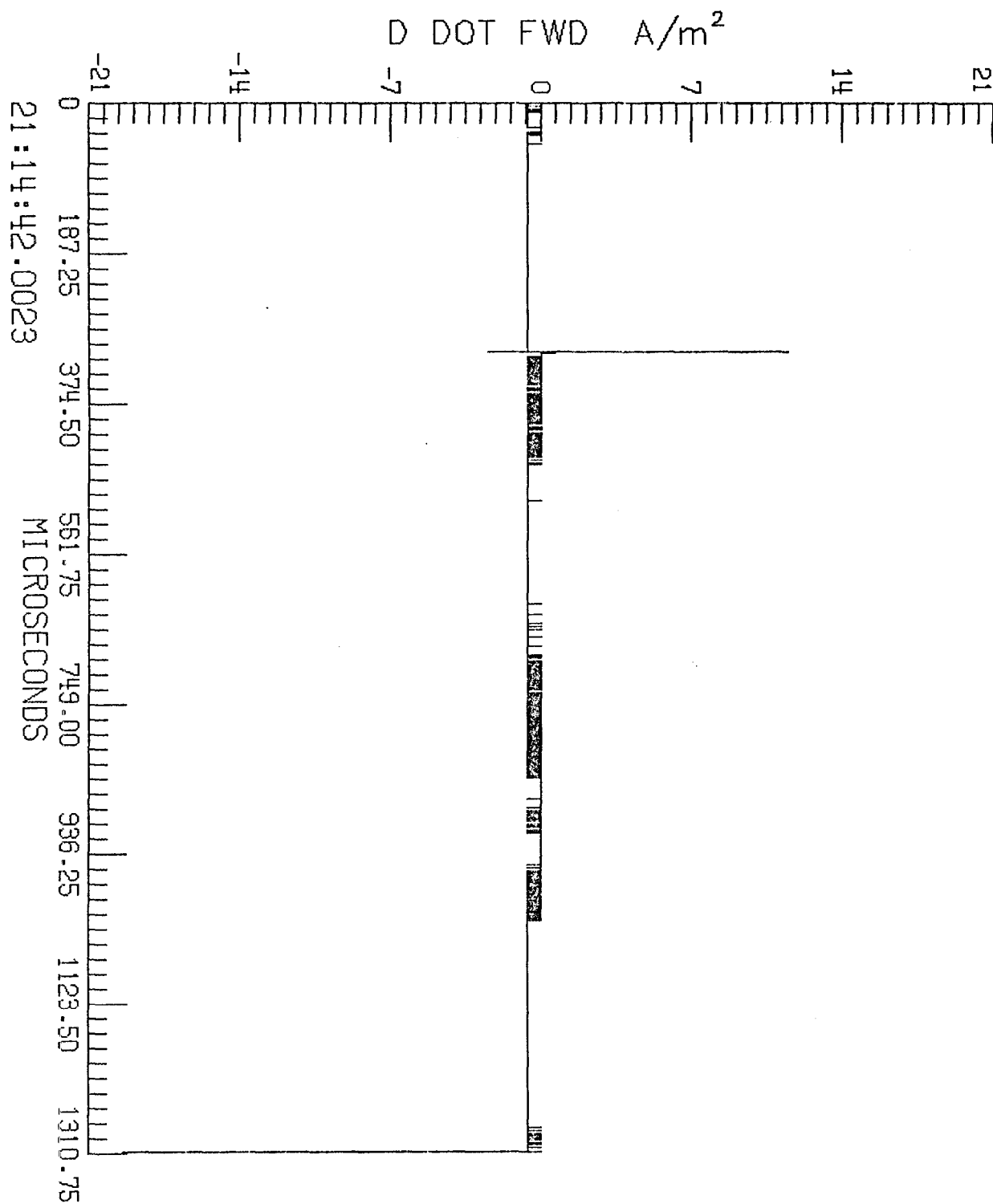


F106 LIGHTNING/TK8/M.THOMAS

TEST NO. 83-

RUN NO. 2

S-001

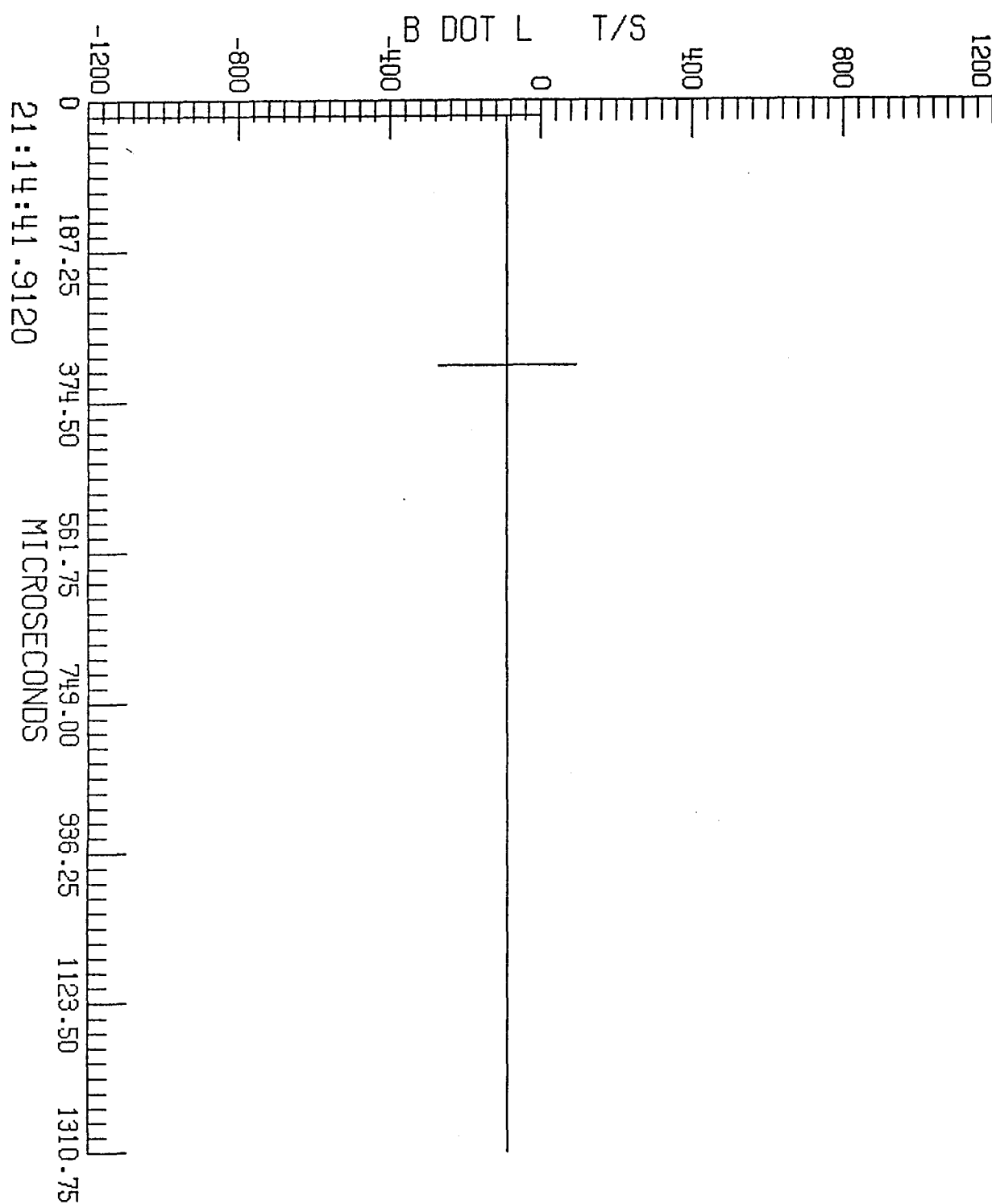


F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83-01

RUN NO. 2

S-001

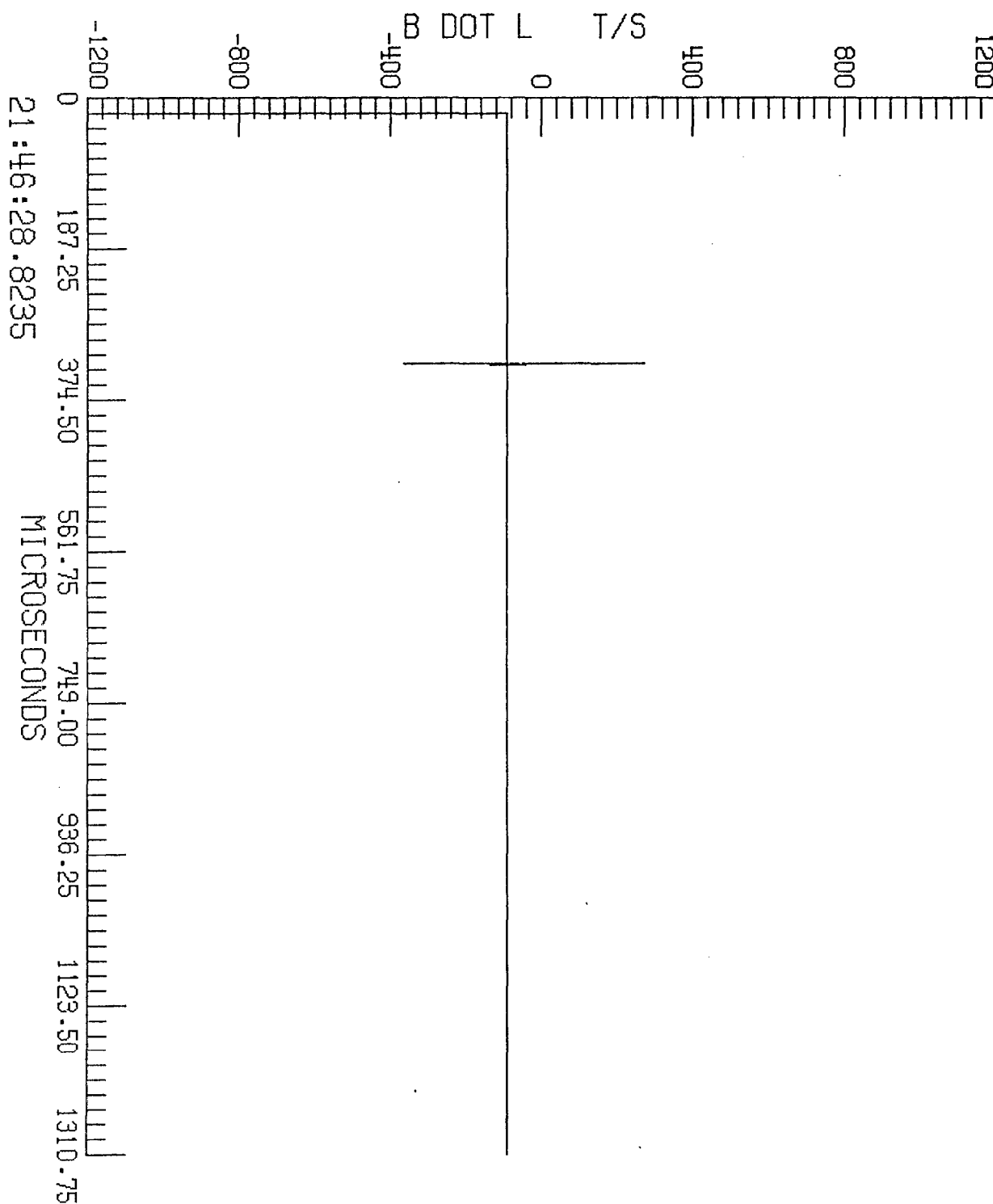


F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83-01

RUN NO. 3

N-001

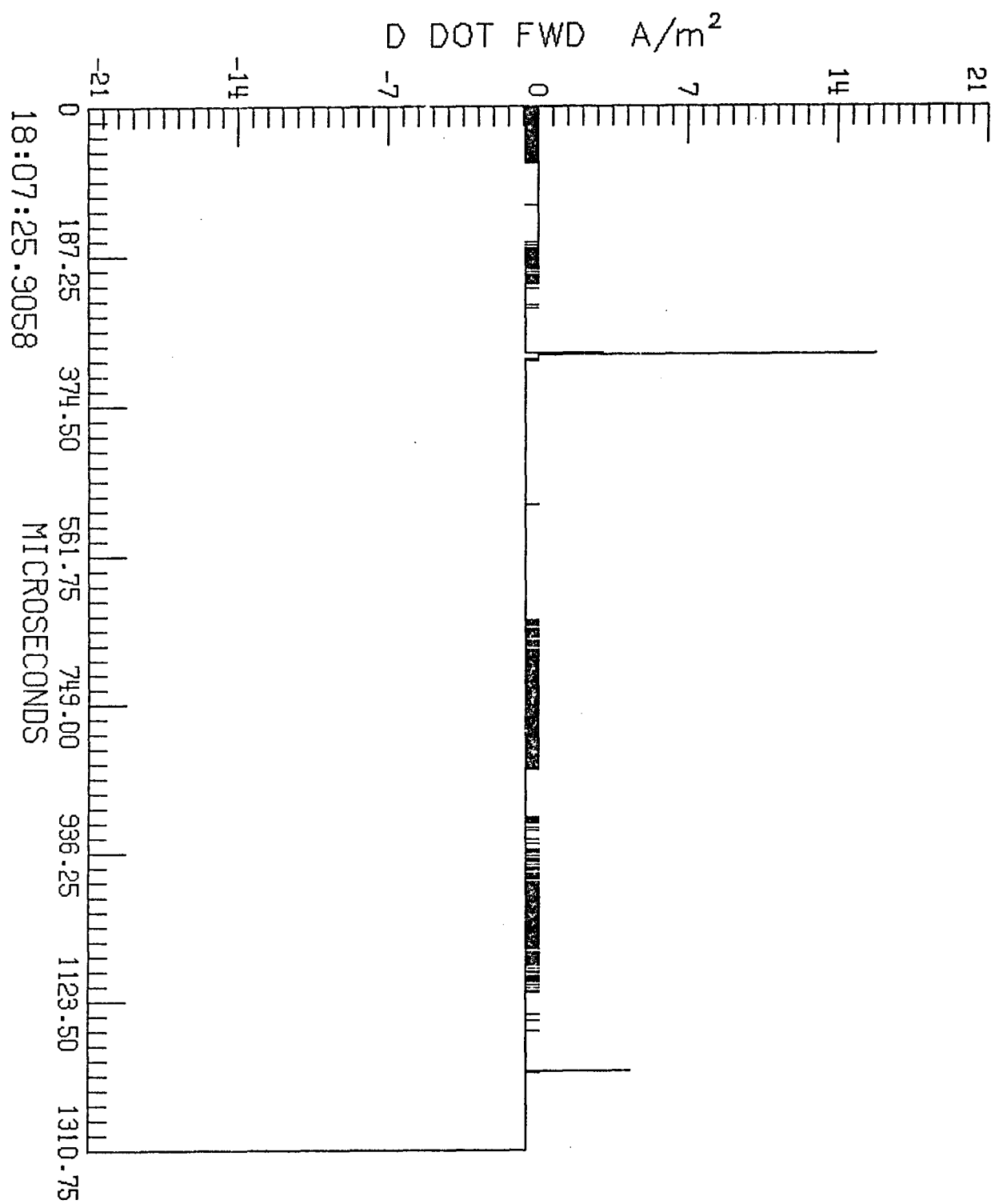


F106 LIGHTNING/TK.8/M.THOMAS

TEST NO. 83

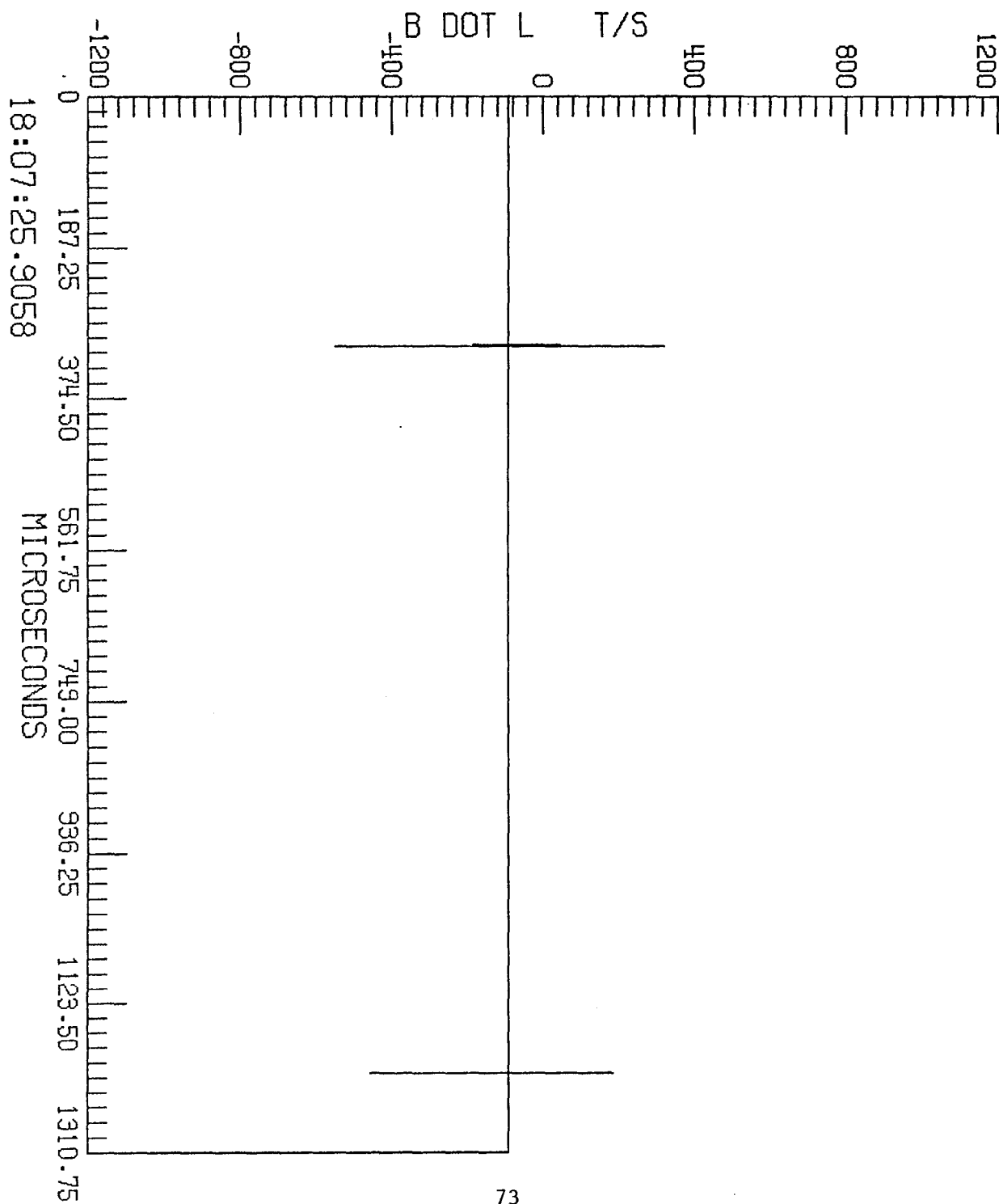
RUN NO. 1

S-001



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 1 S-001

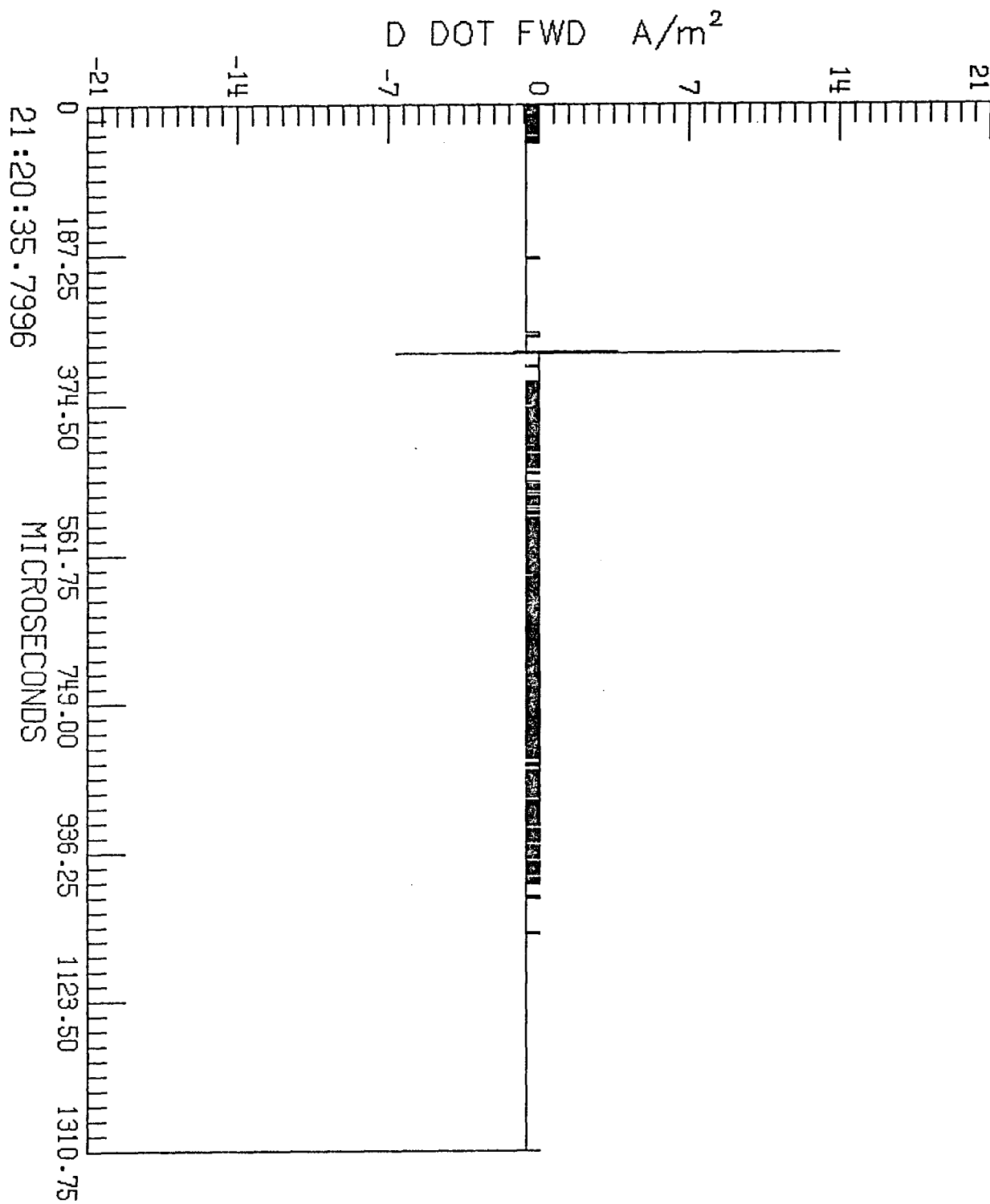
TEST NO. 83



F106 LIGHTNING/TK.8/M.THOMAS
RUN NO. 1

S-001

TEST NO. 83

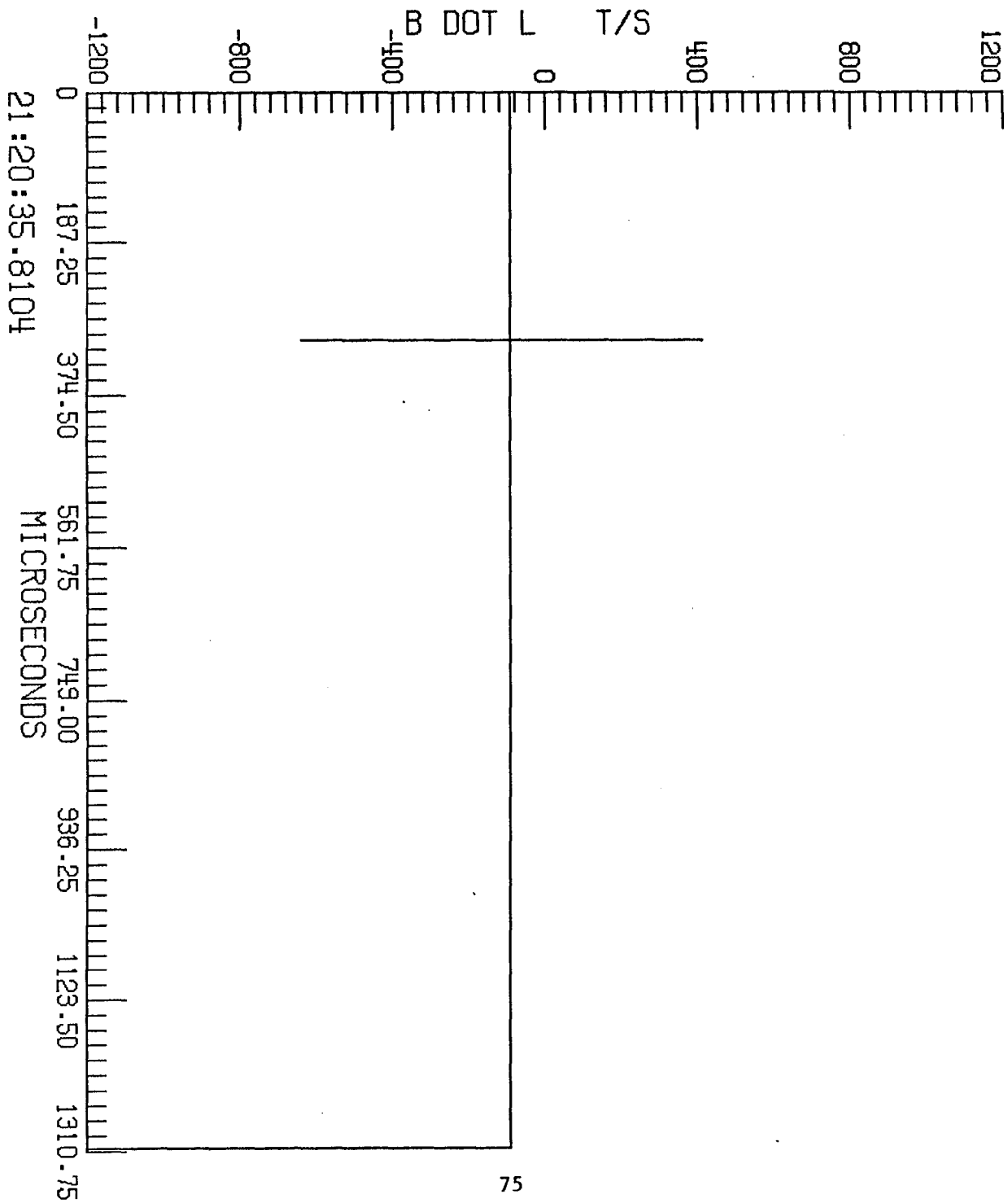


F106 LIGHTNING/TK 10

TEST NO. 83-024

RUN NO. 1

S-001

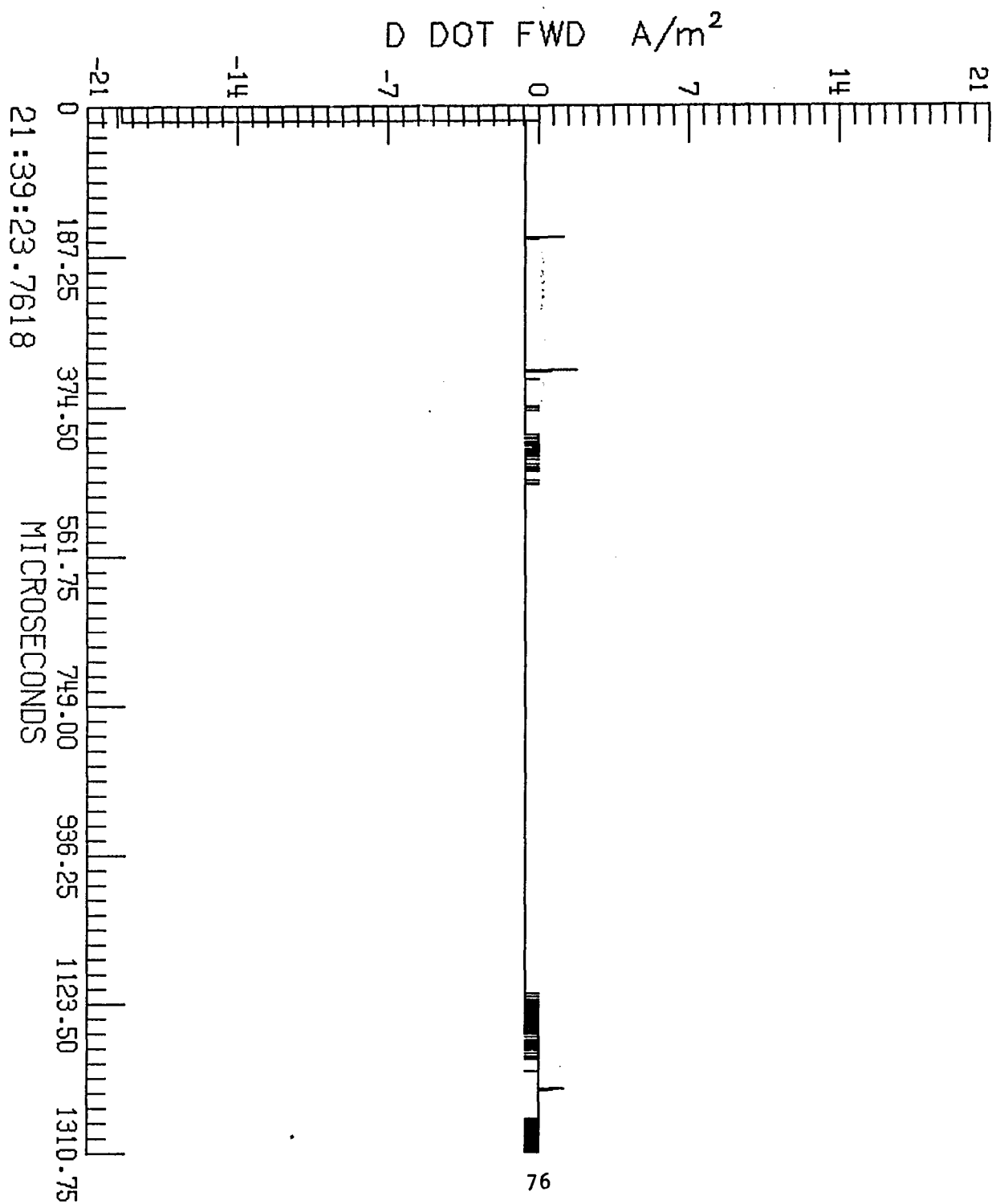


F106 LIGHTNING/TK.8/M.THOMAS

TEST NO. 83

RUN NO. 2

S-003

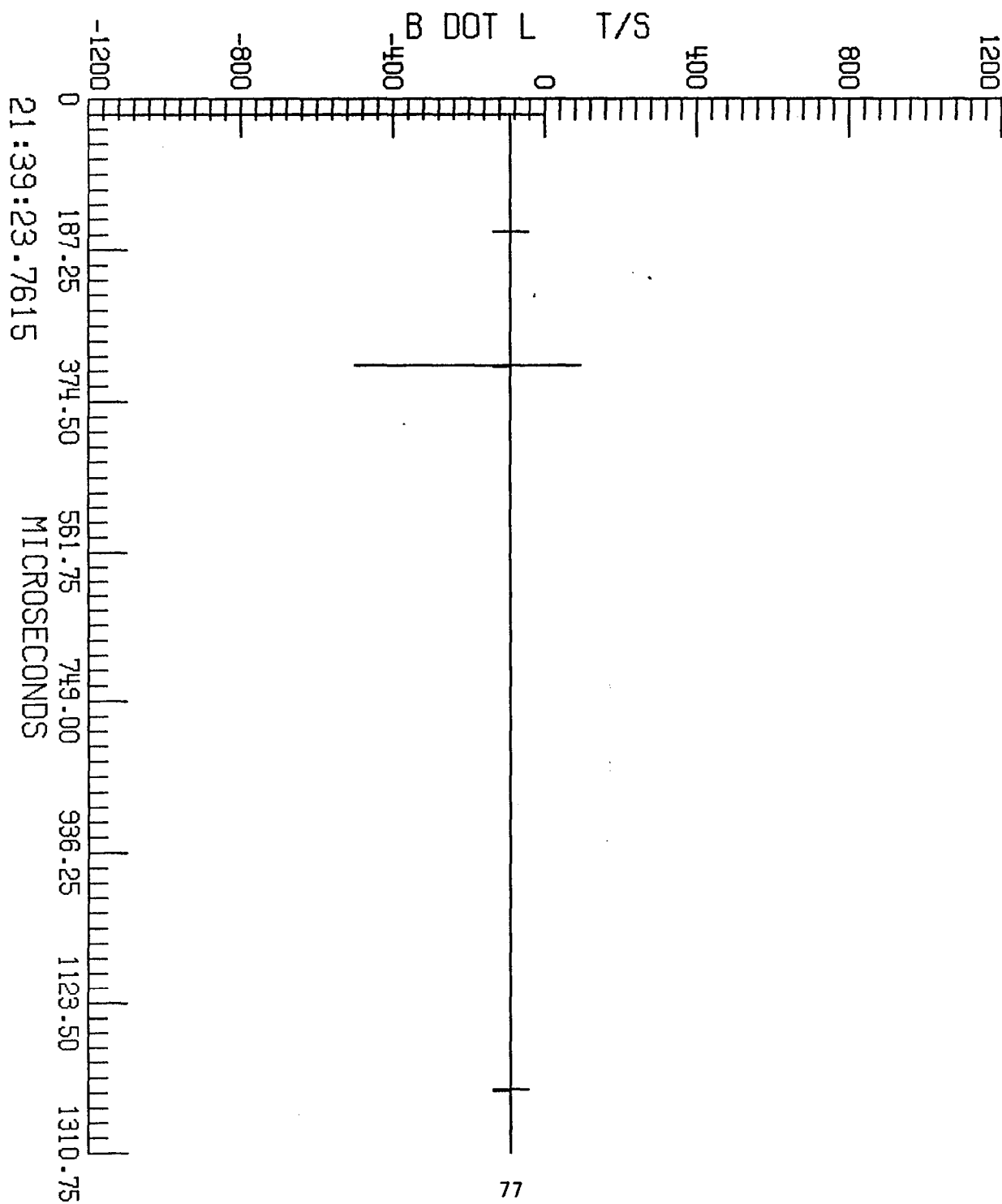


F106 LIGHTNING/TK 10

RUN NO. 2

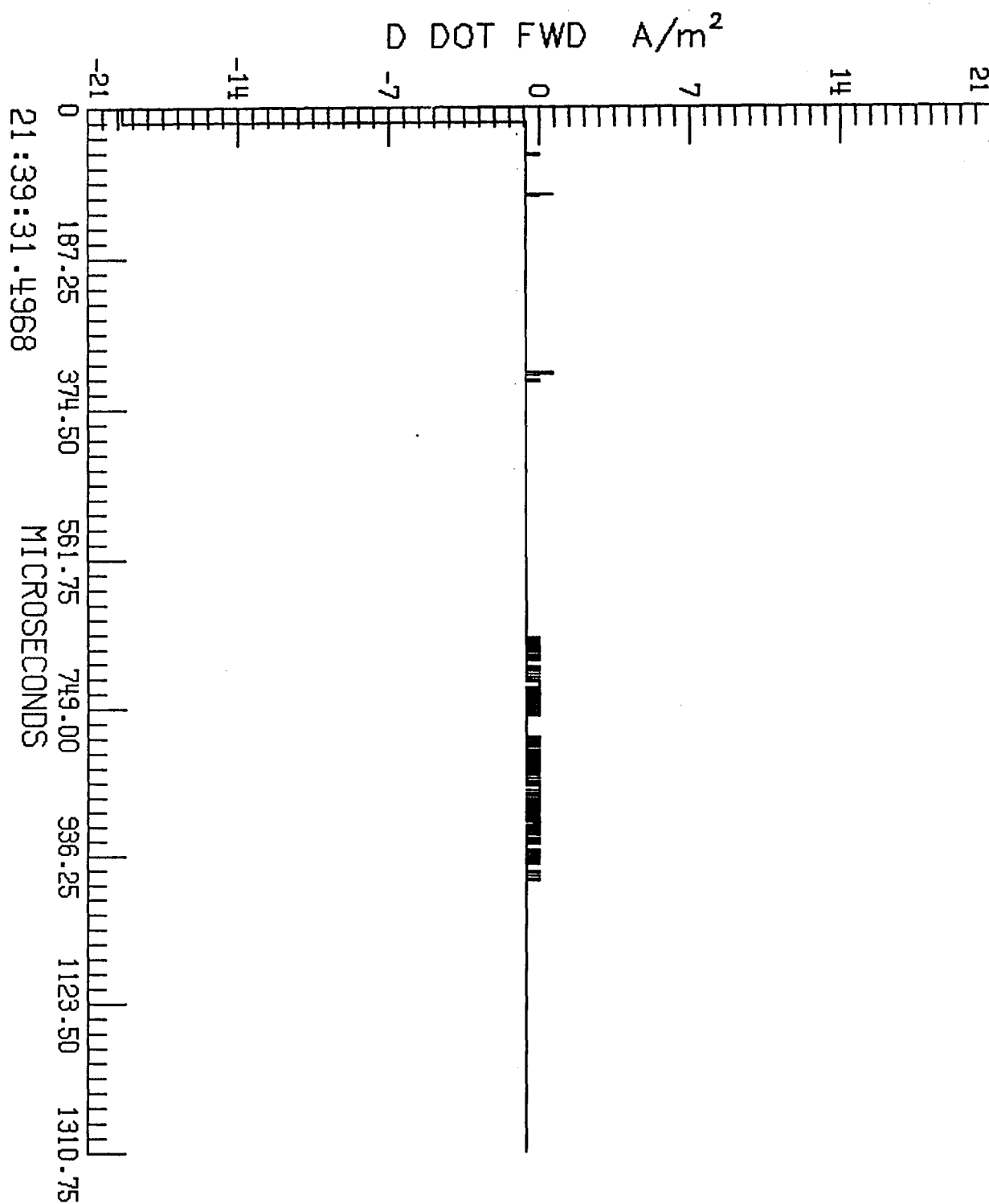
S-003

TEST NO. 83-024



F106 LIGHTNING/TK.8/M.THOMAS
RUN NO. 3 N-001

TEST NO. 83

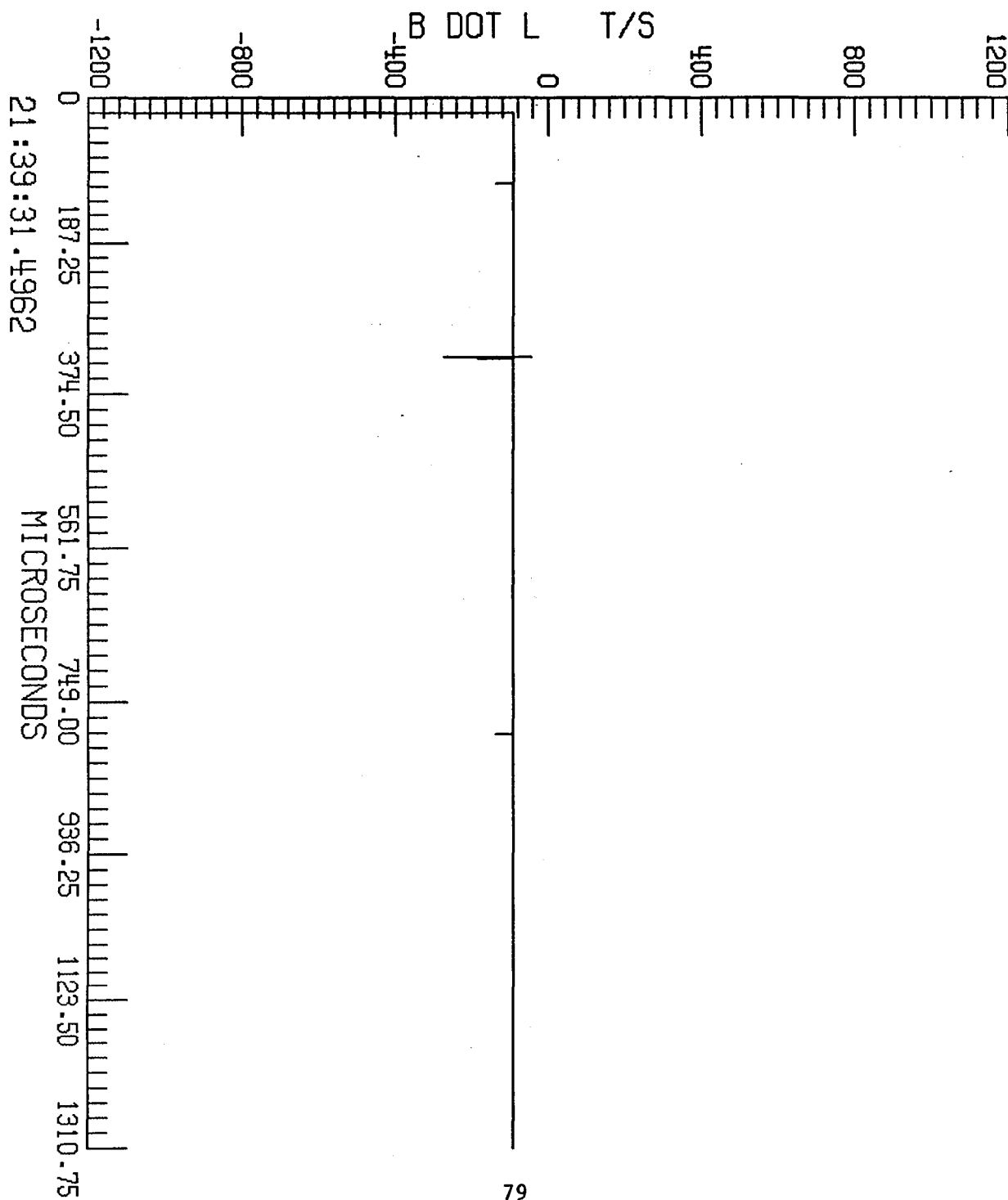


F106 LIGHTNING/TK 10

RUN NO. 3

N-001

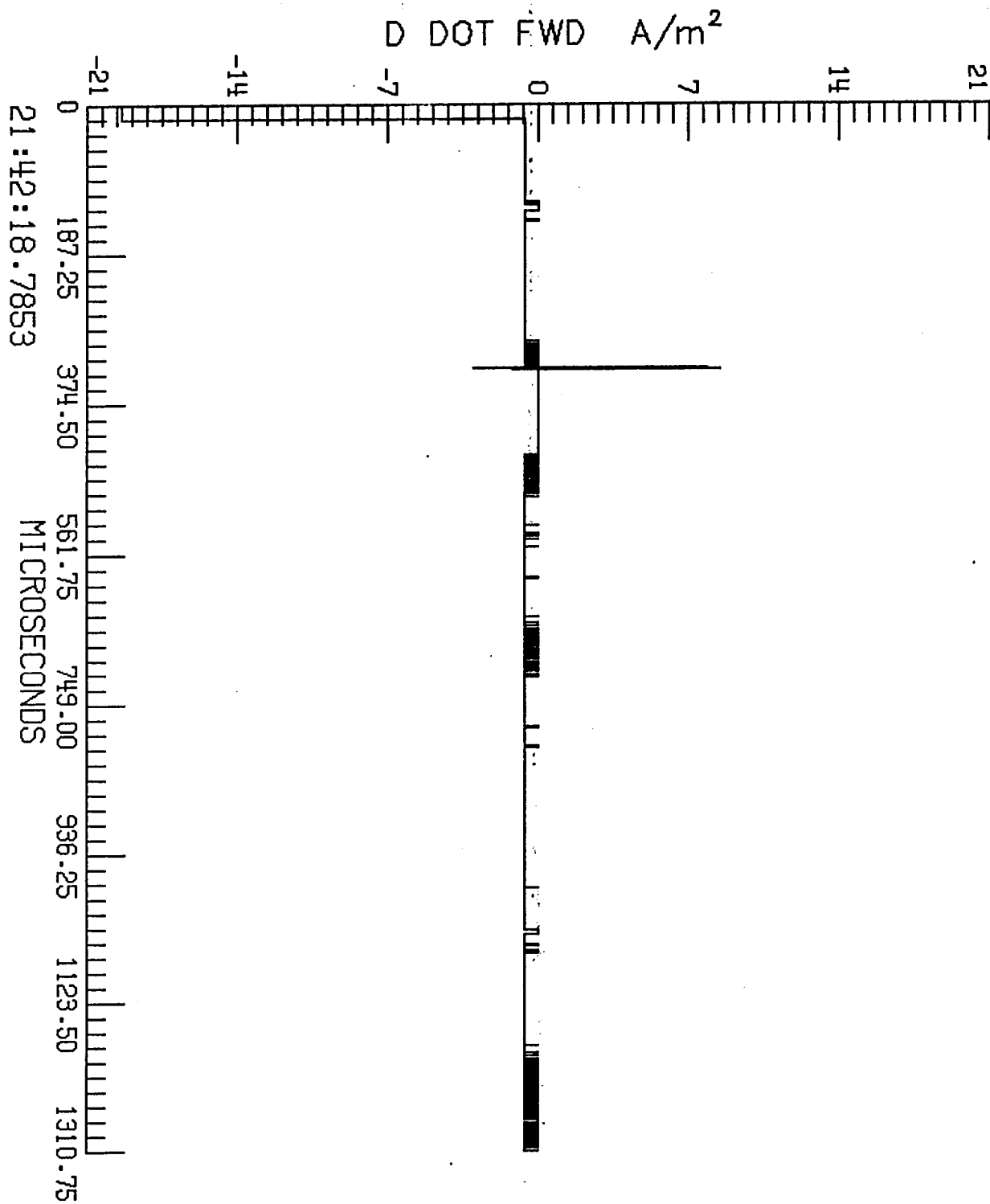
TEST NO. 83-024



F106 LIGHTNING/TK.8/M.THOMAS
RUN NO. 4

S-004

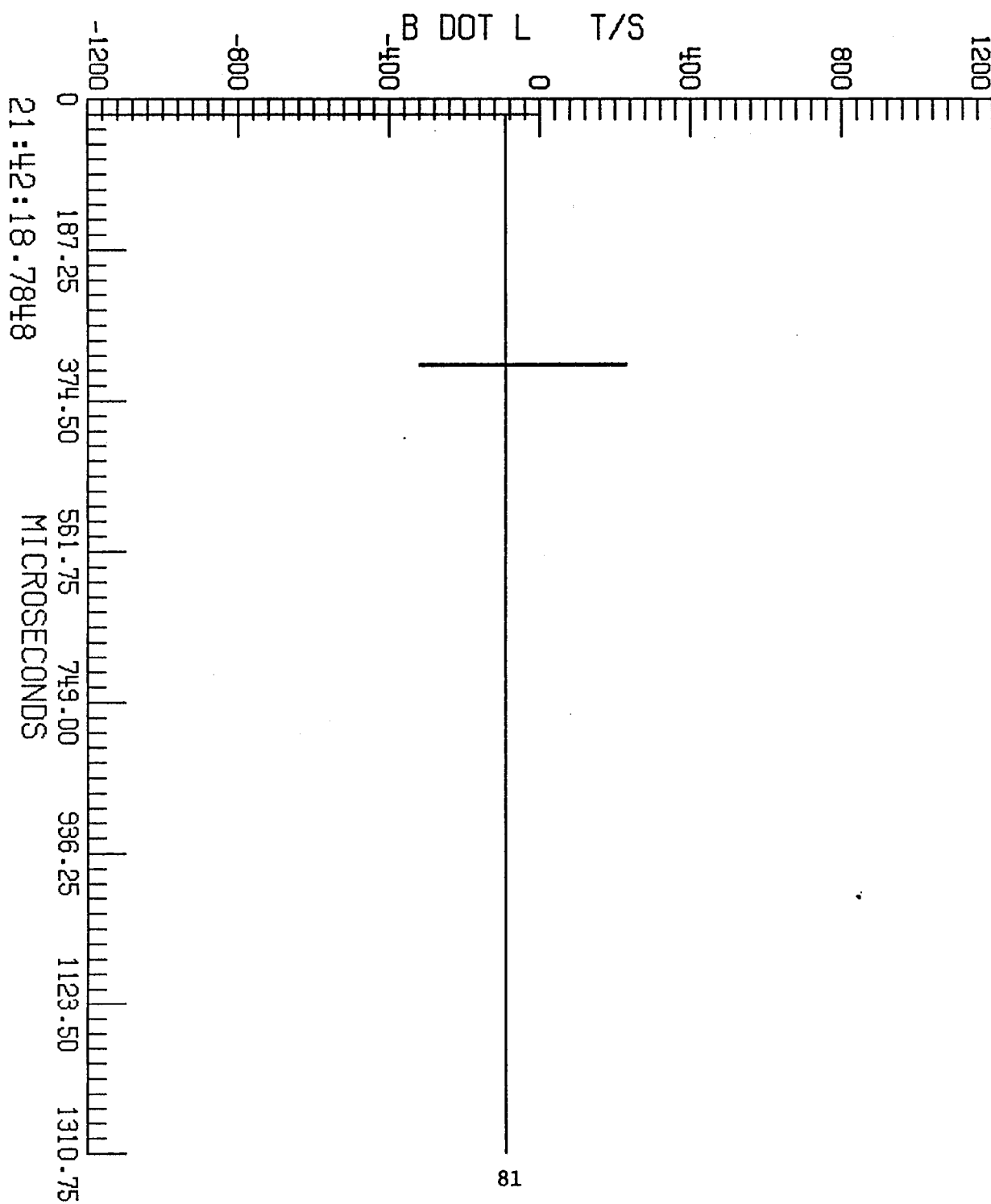
TEST NO. 83



F106 LIGHTNING/TK 10
RUN NO. 4

S-004

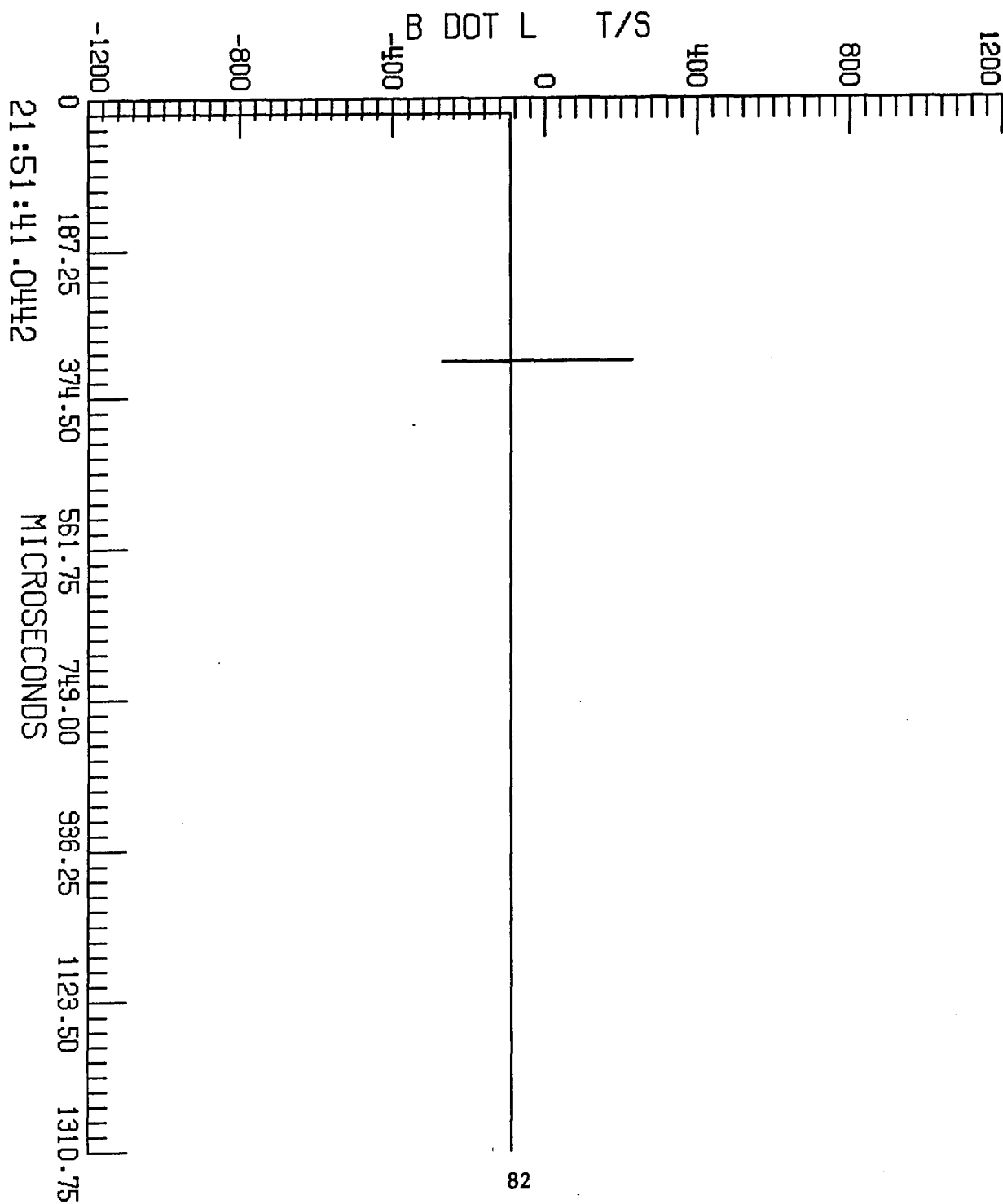
TEST NO. 83-024



F106 LIGHTNING/TK 10
RUN NO. 5

N-002

TEST NO. 83-024

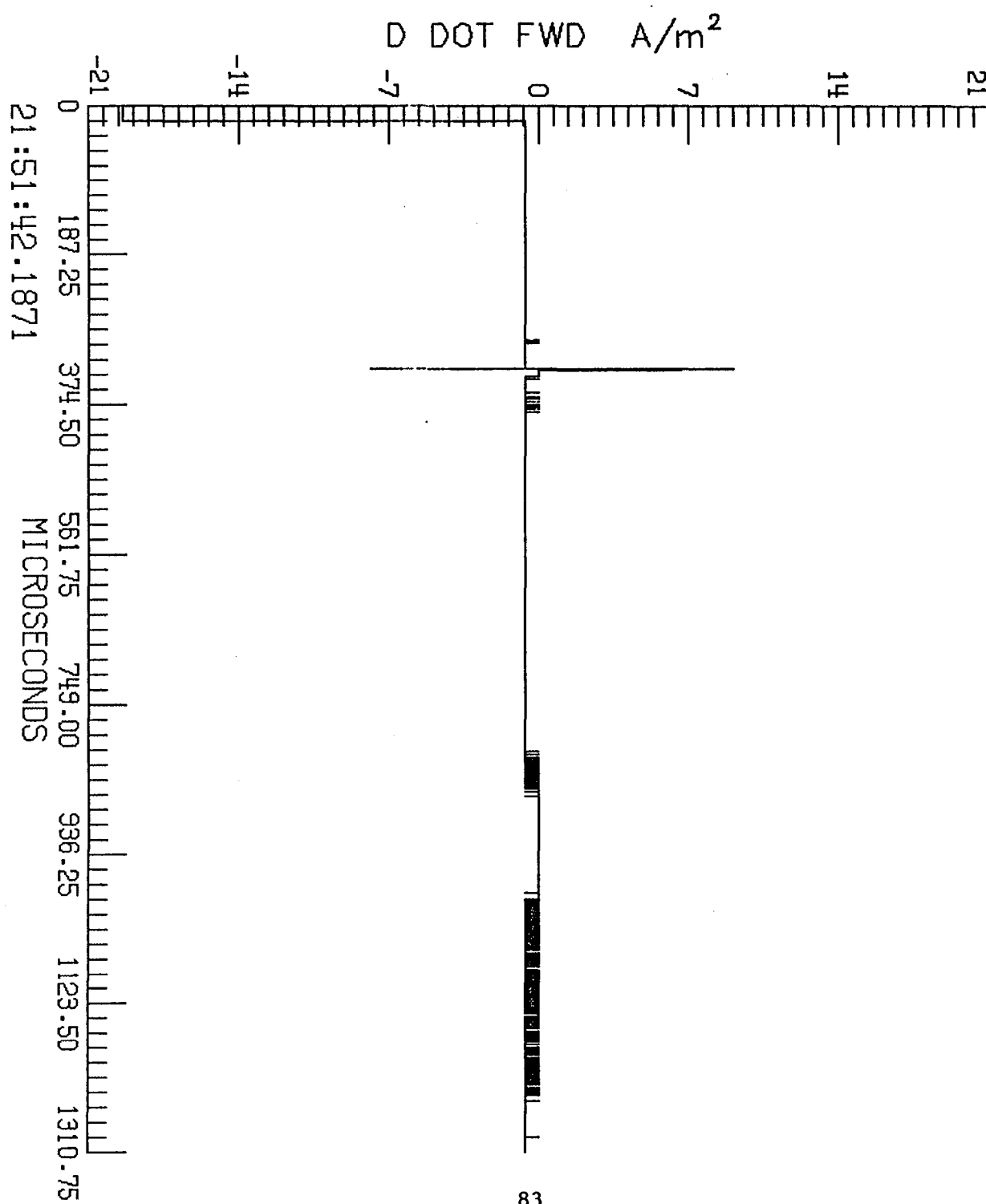


F106 LIGHTNING/TK-8/M.THOMAS

TEST NO. 83

RUN NO. 5

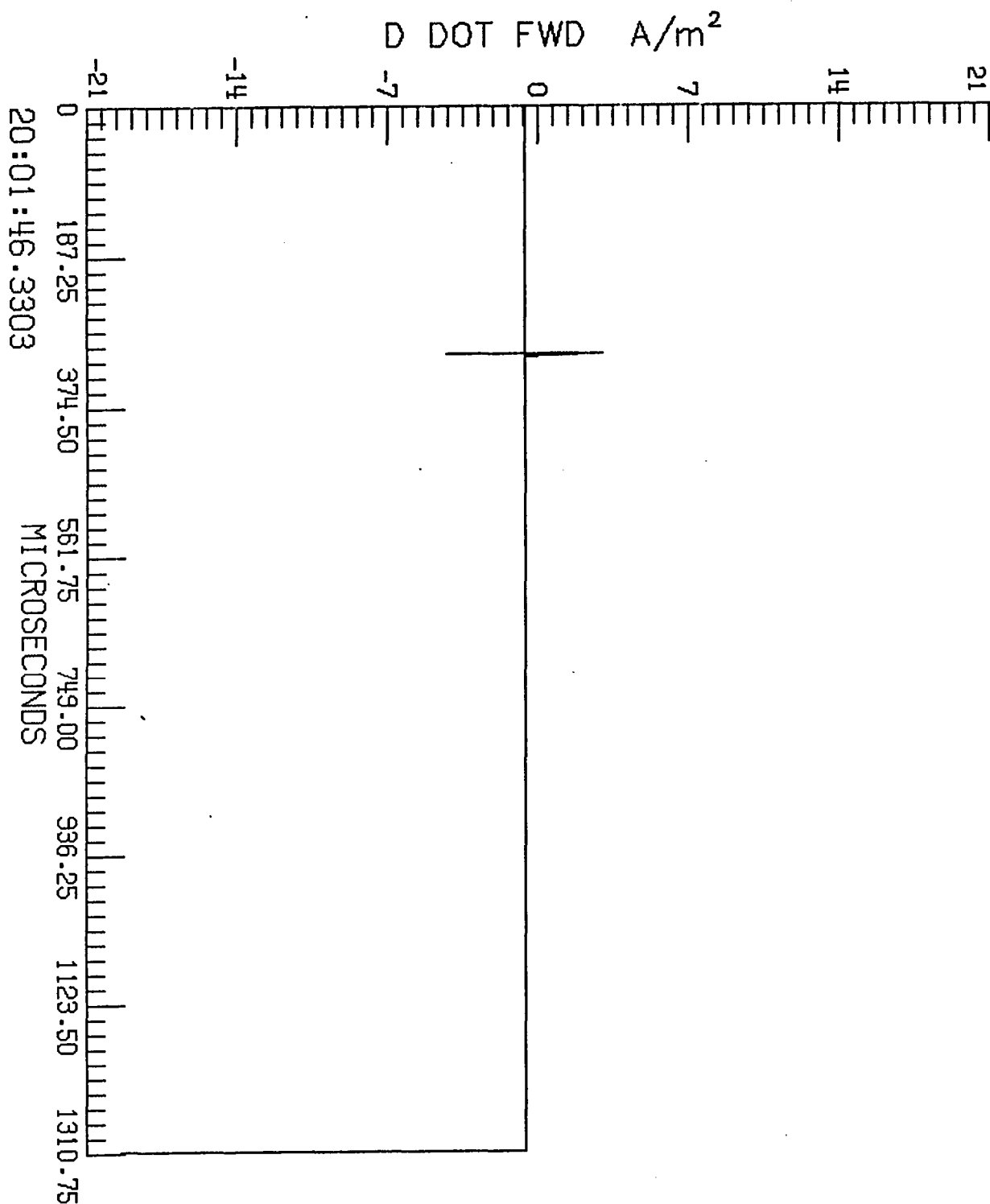
S-005



F106 LIGHTNING/TK.8/M.THOMAS
RUN NO. 4

N-005

TEST NO. 83-

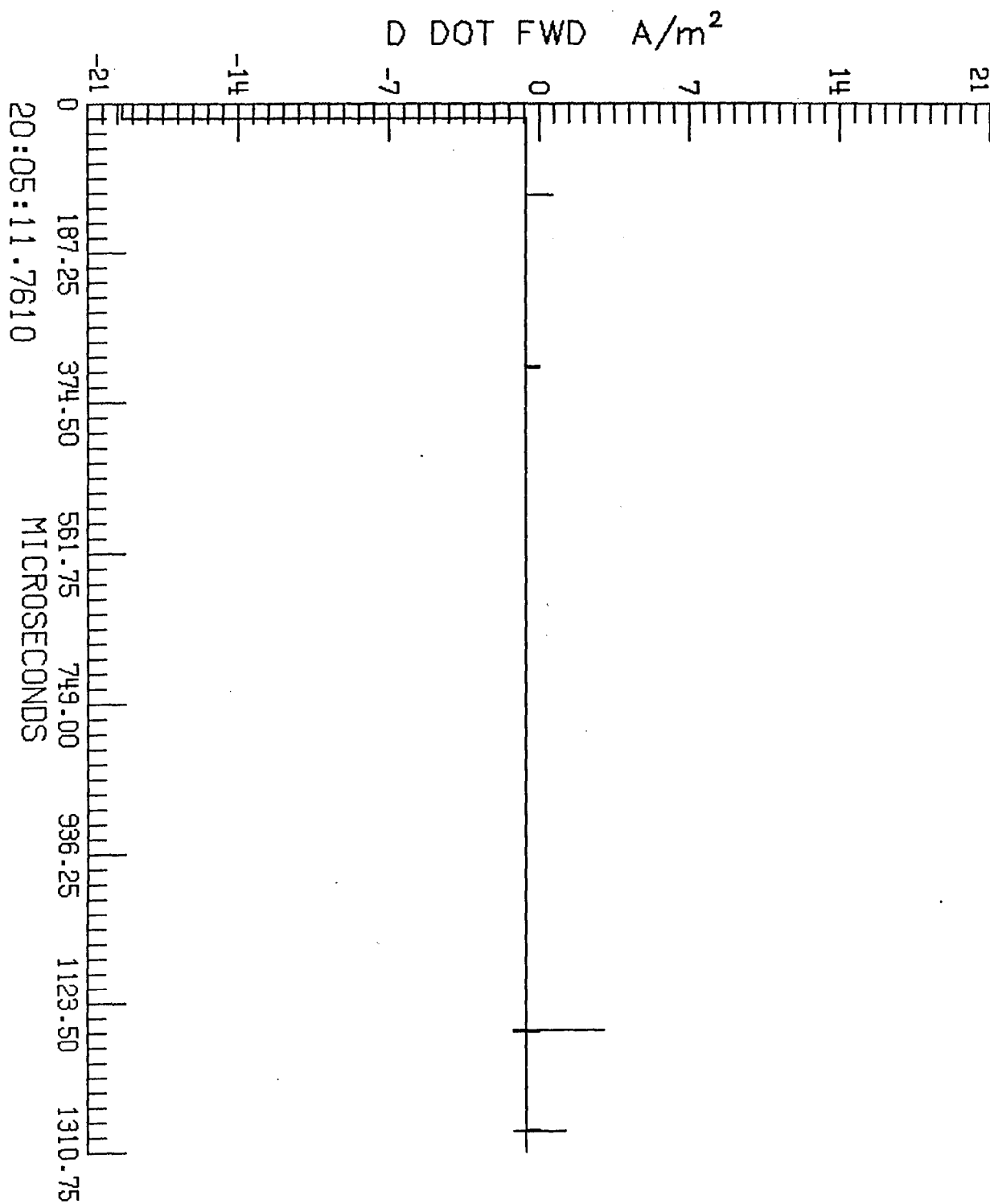


F106 LIGHTNING/TK.8/M.THOMAS

TEST NO. 83-

RUN NO. 5

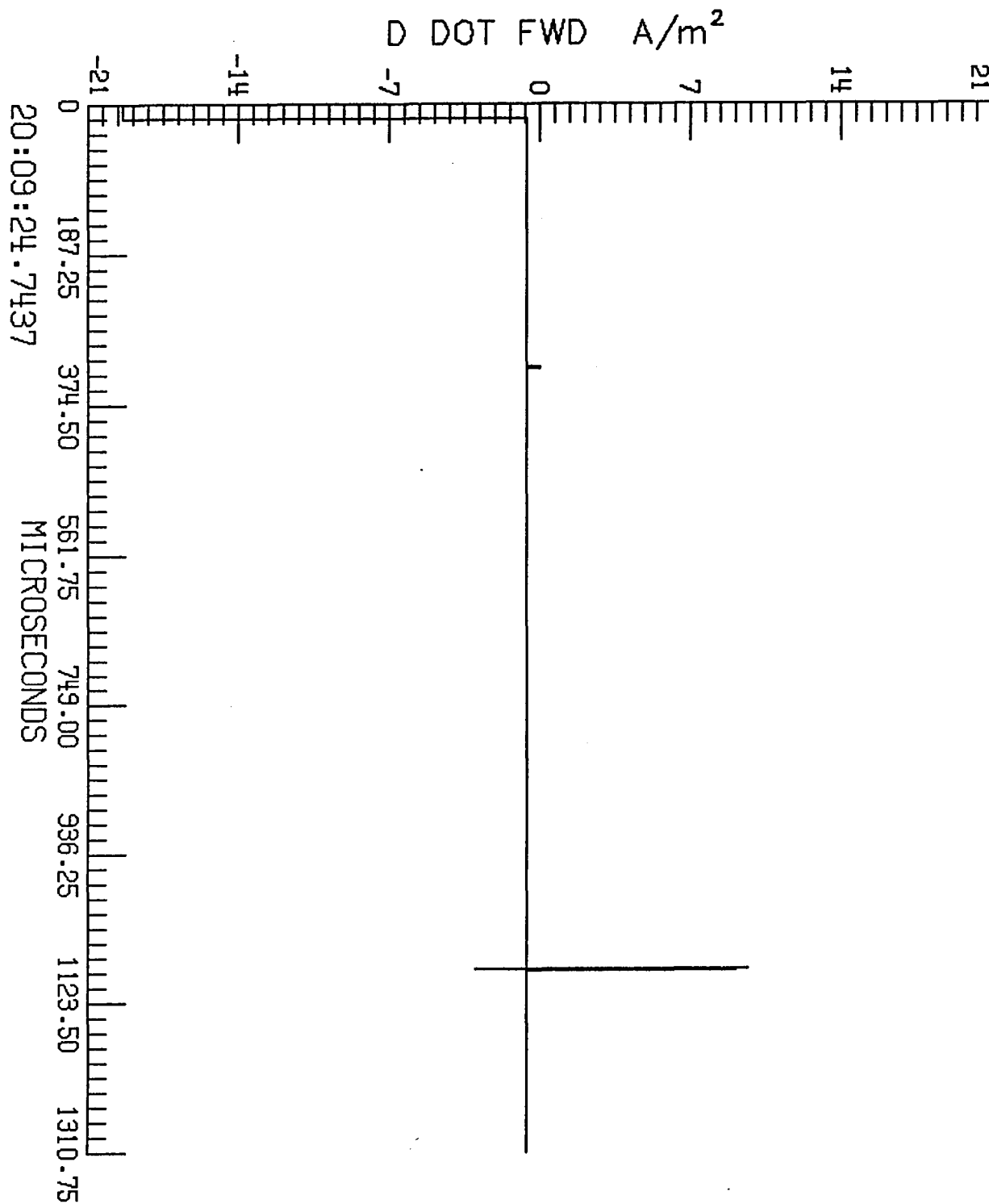
S-001



F106 LIGHTNING/TK.8/M.THOMAS
RUN NO. 6

S-002

TEST NO. 83-

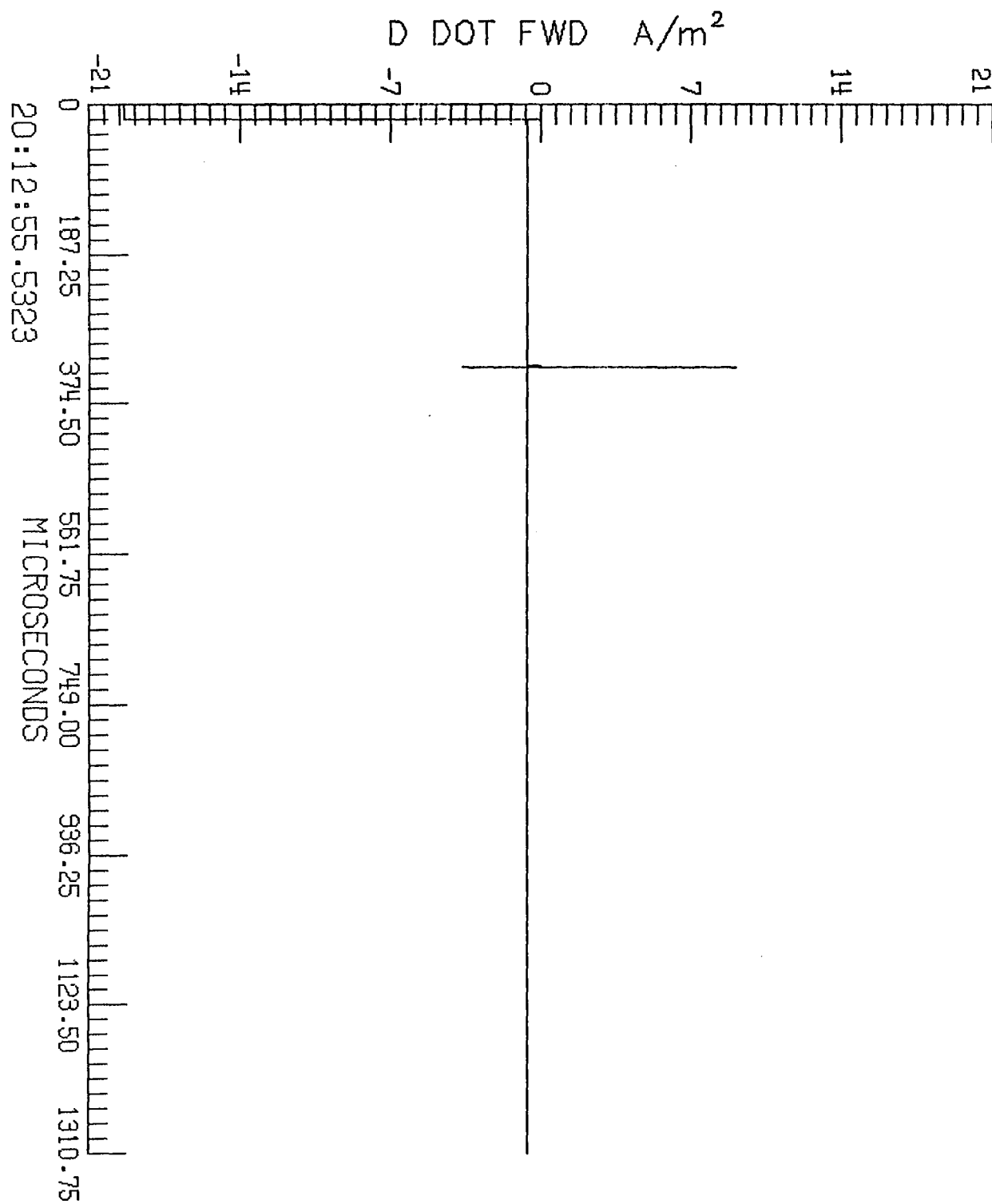


F106 LIGHTNING/TK.8/M.THOMAS

TEST NO. 83.

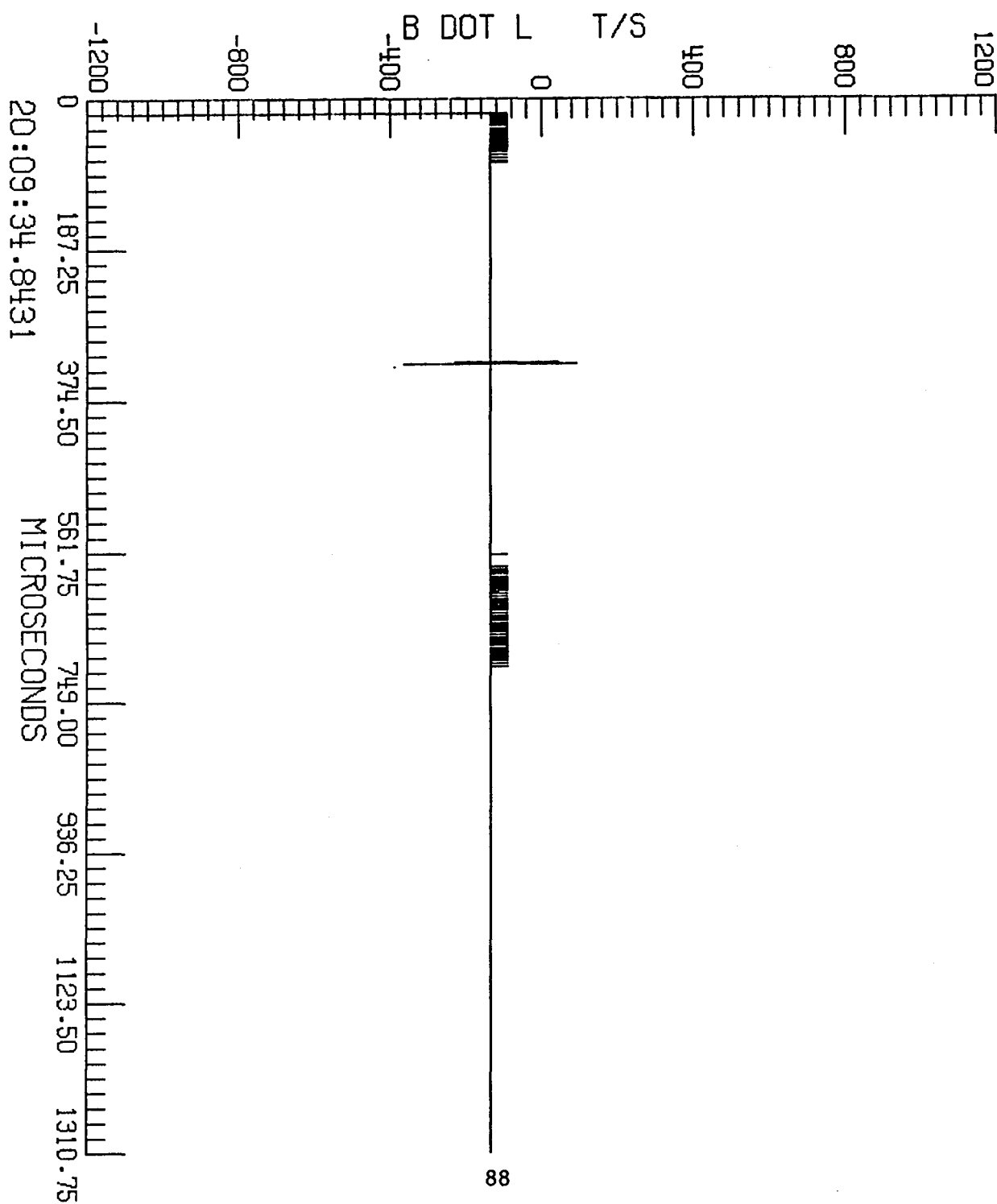
RUN NO. 8

S-004



F-106 LIGHTNING/M. THOMAS
RUN NO. 7 S-003

TEST NO. 83

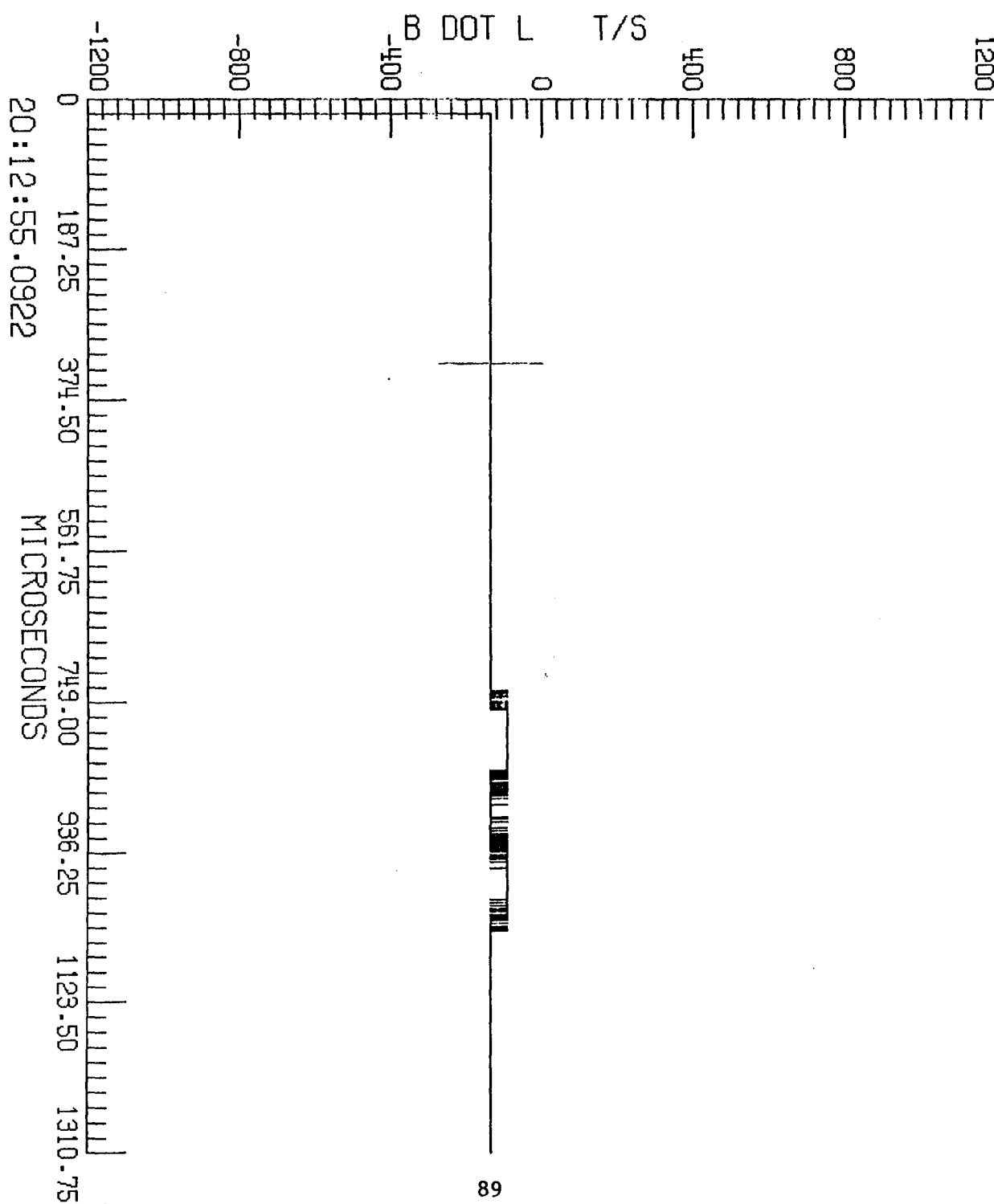


F-106 LIGHTNING/M. THOMAS

TEST NO. 83

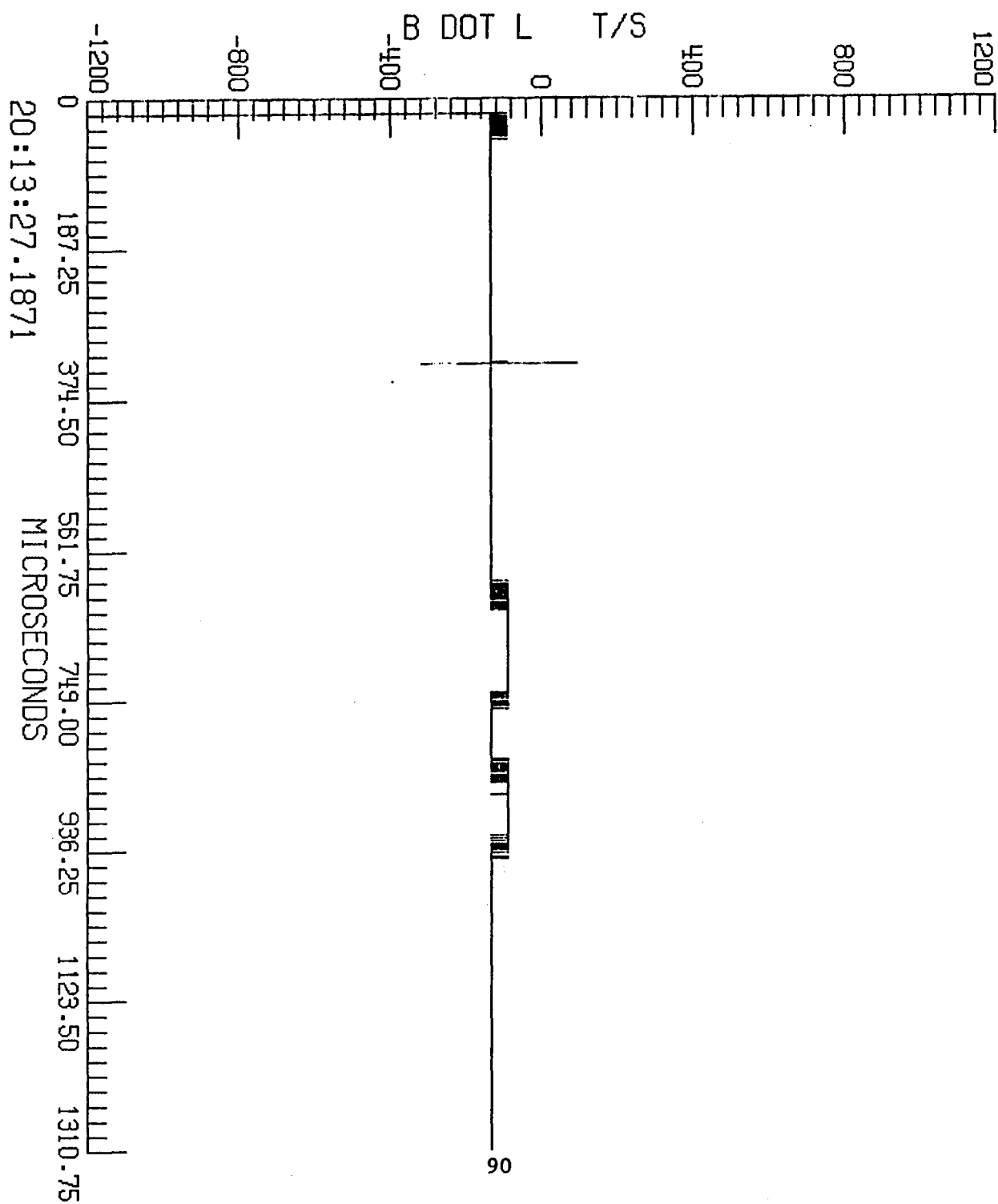
RUN NO. 8

S-004



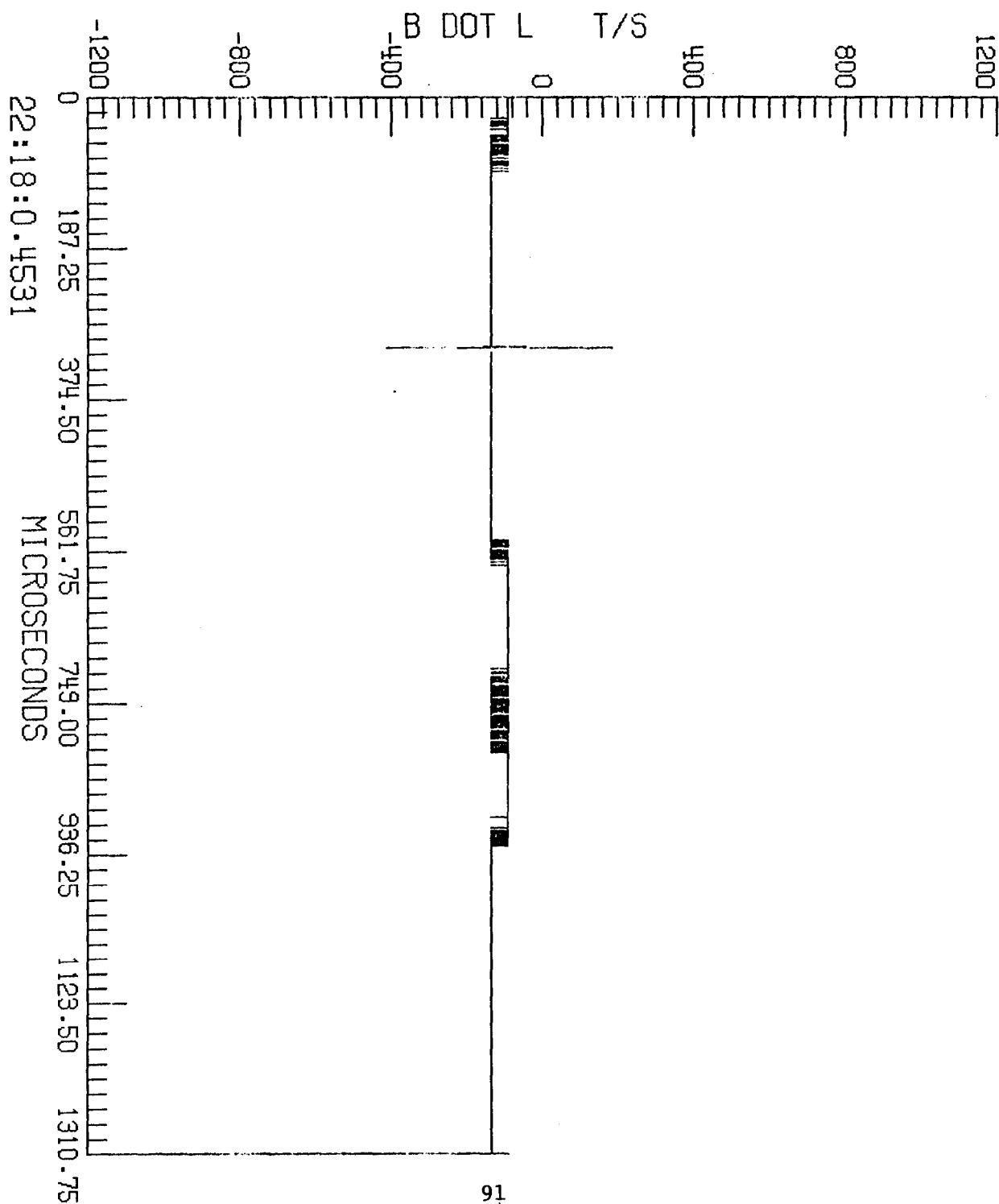
F-106 LIGHTNING/M. THOMAS
RUN NO. 9 N-006

TEST NO. 83



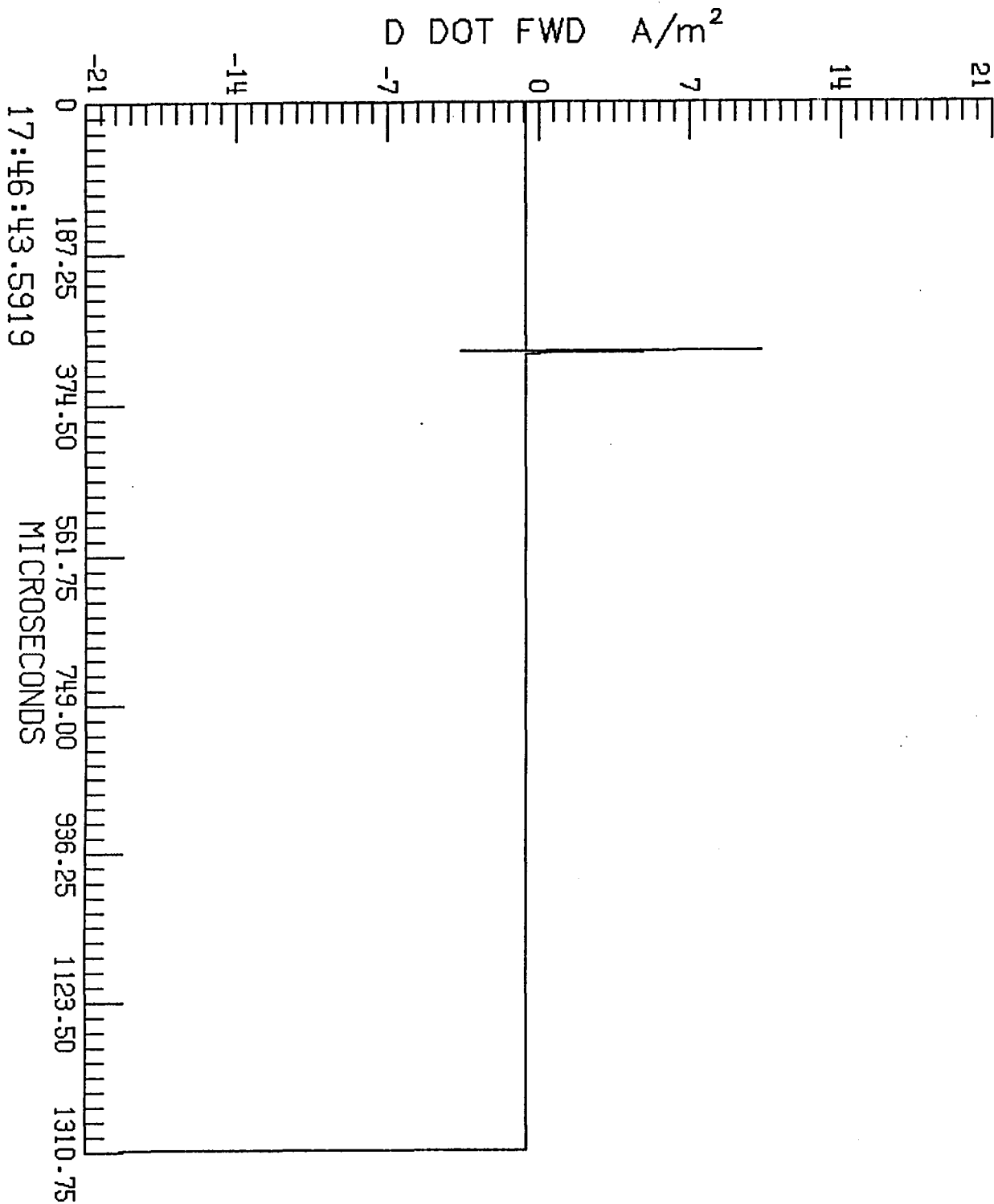
F-106 LIGHTNING/M. THOMAS
RUN NO. A1 N-001

TEST NO. 83



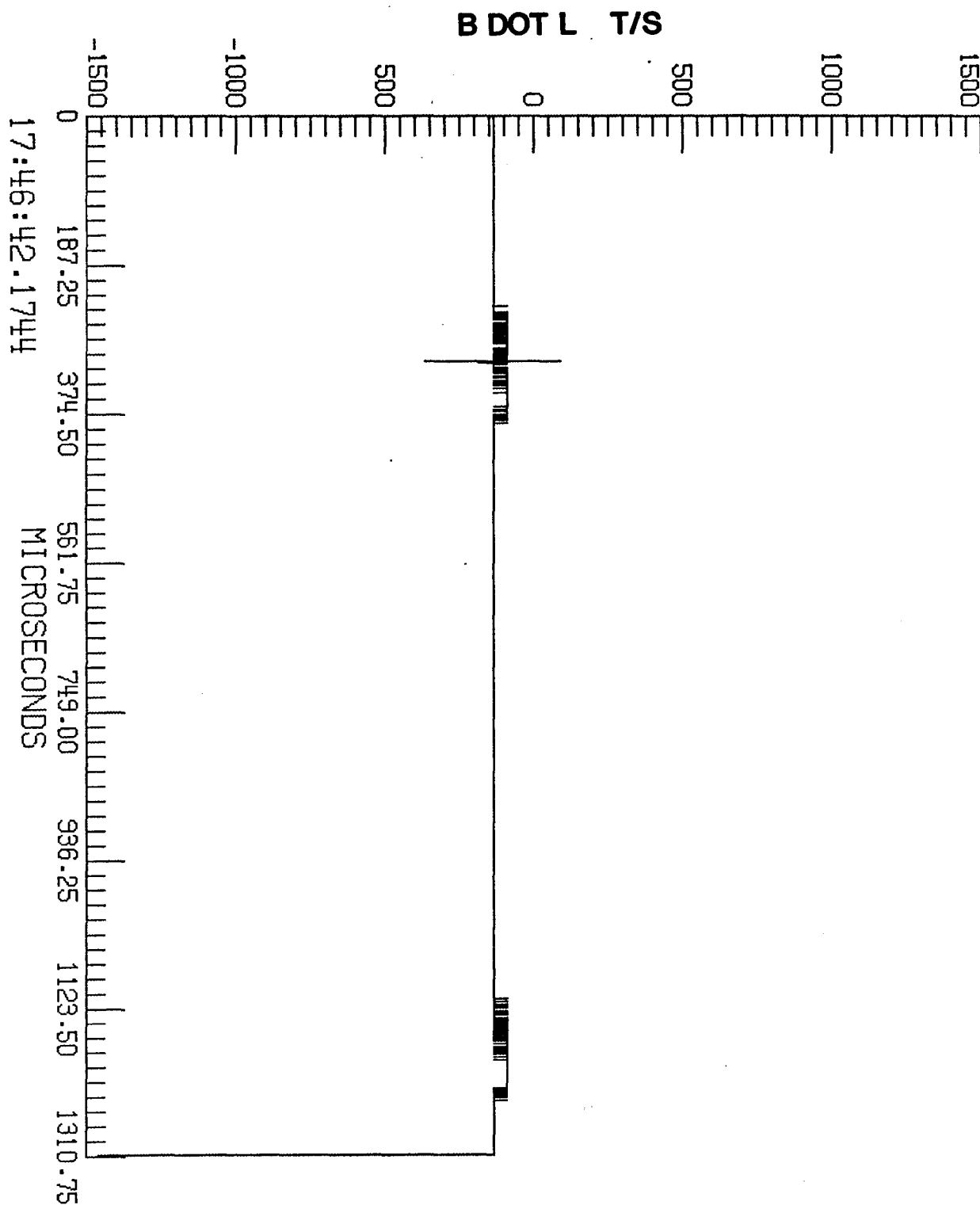
F106 LIGHTNING/TK 8/THOMAS
RUN NO. 1 N-002

TEST NO. 83-



F106 LIGHTNING TK 10/THOMAS
RUN NO. 1 N-001

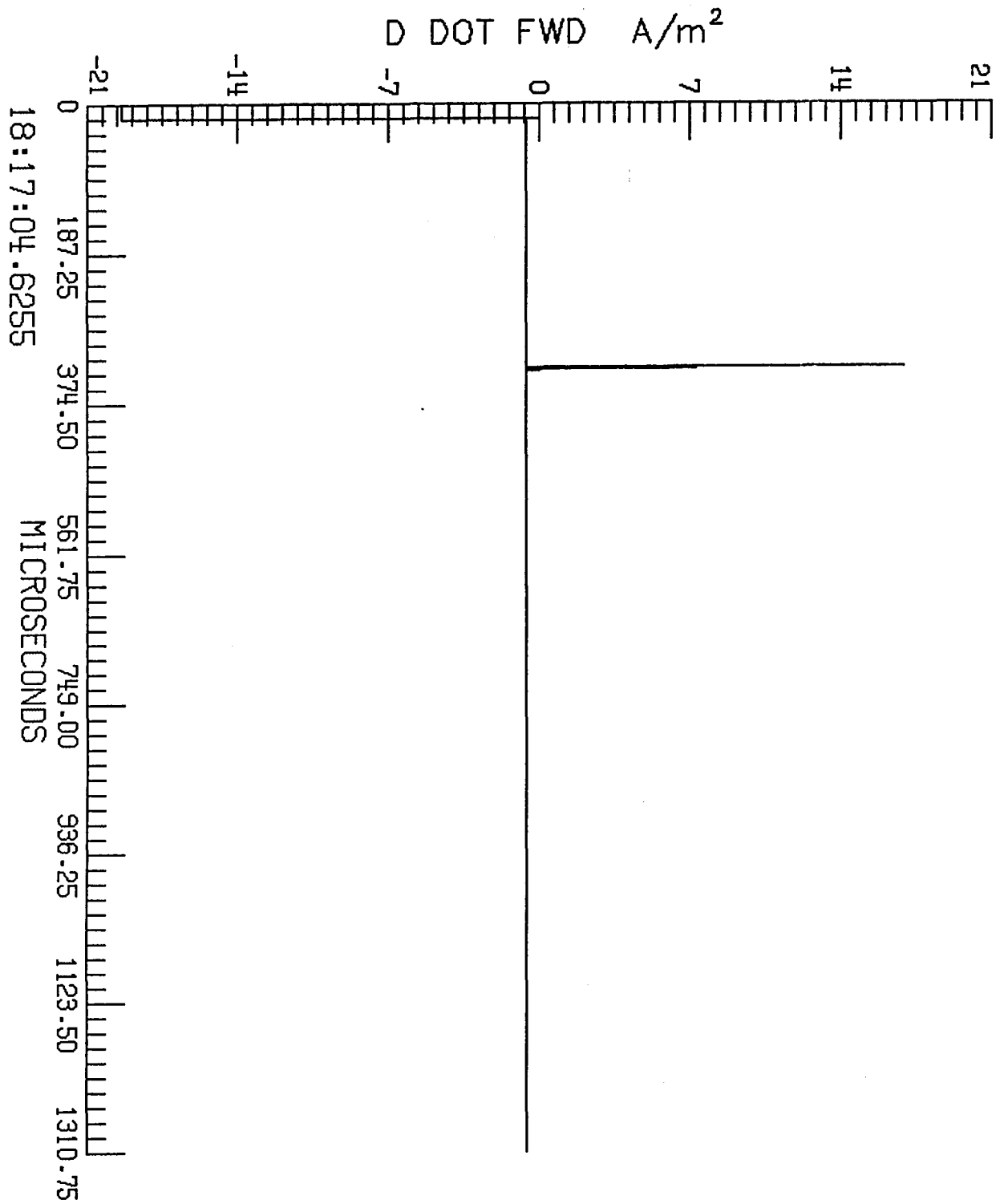
TEST NO. 83-



F106 LIGHTNING/TK 8/THOMAS
RUN NO. 2

S-001

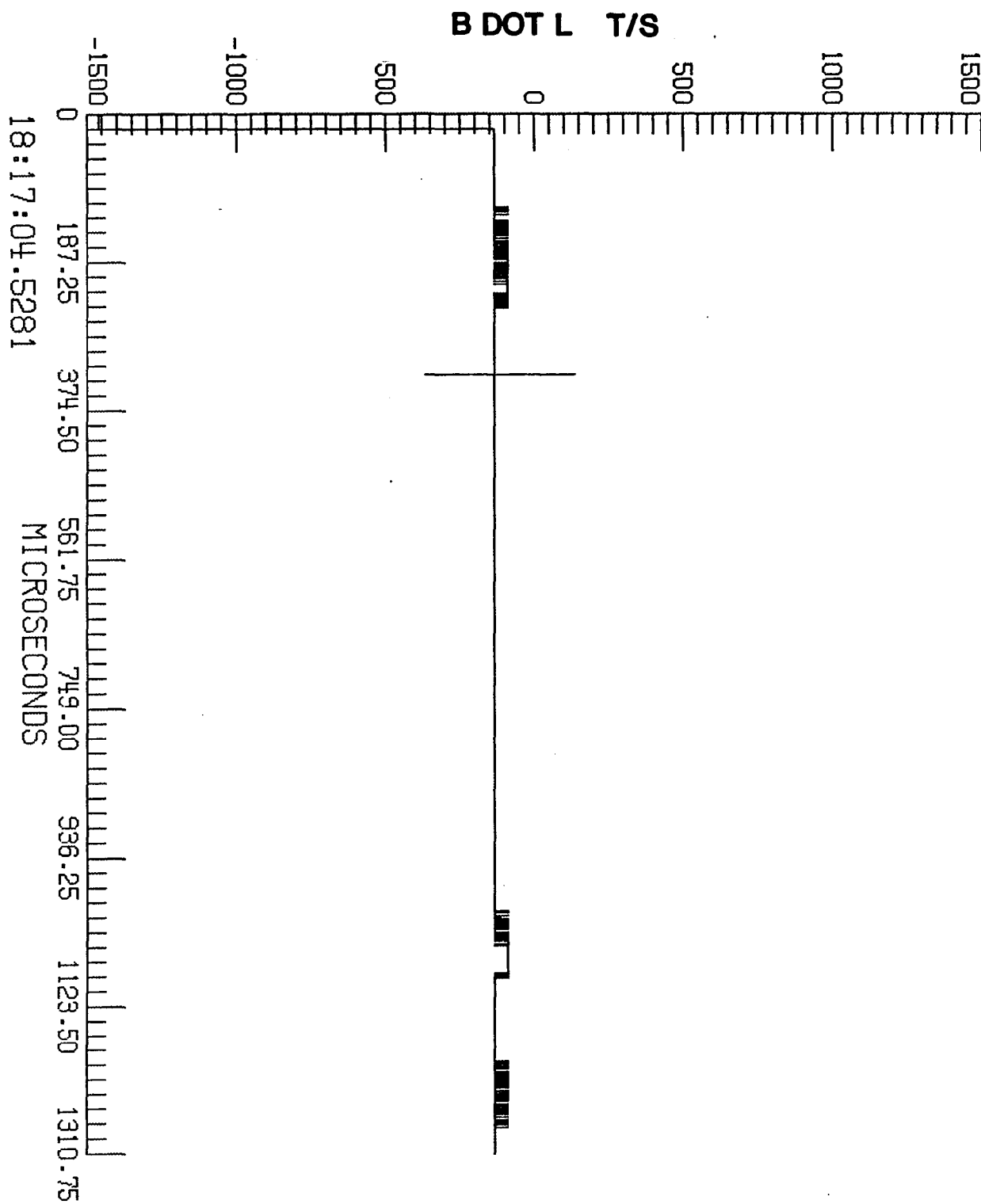
TEST NO. 83-



F106 LIGHTNING TK 10/THOMAS

TEST NO. 83-

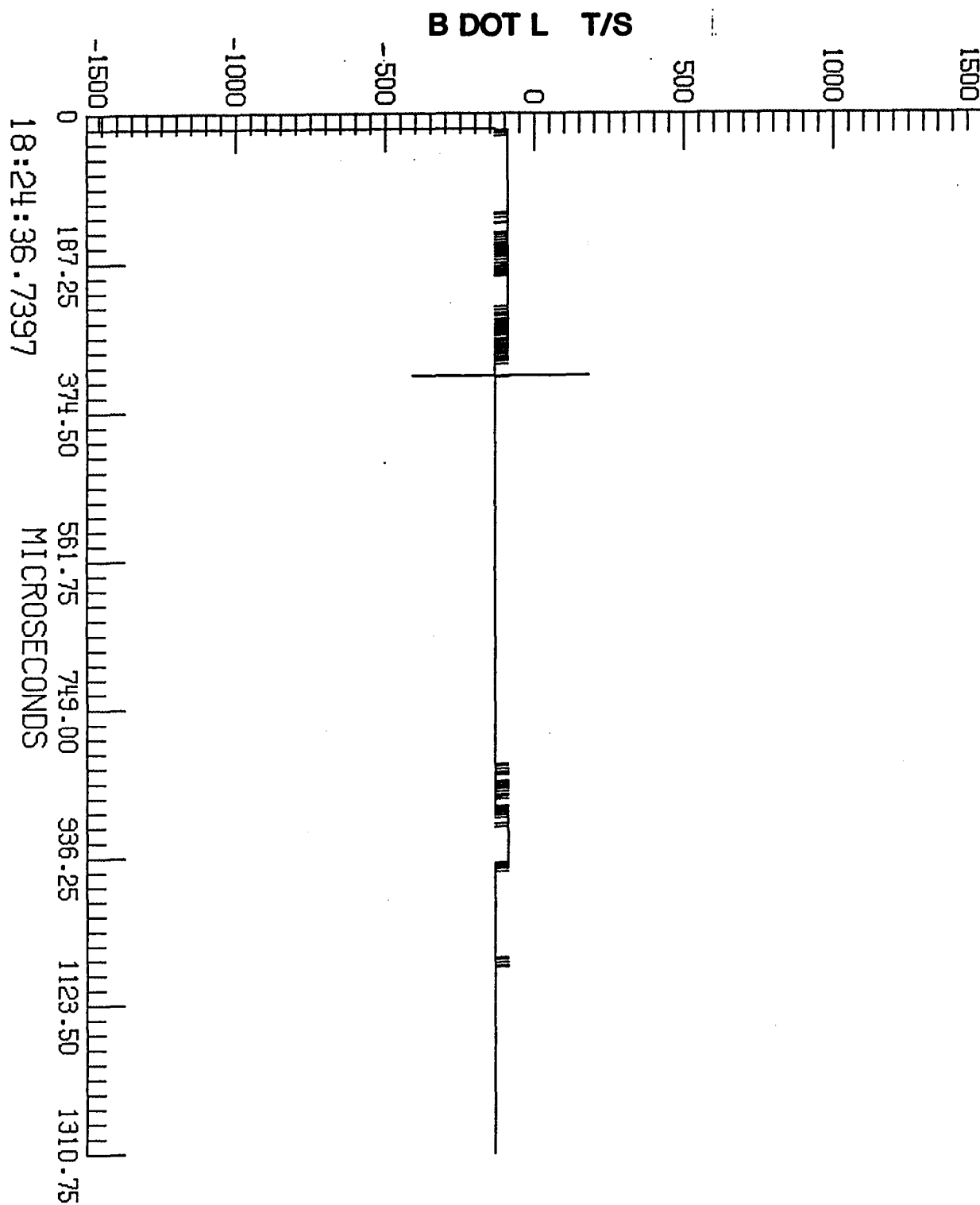
RUN NO. 2 S-001



F106 LIGHTNING TK 10/THOMAS

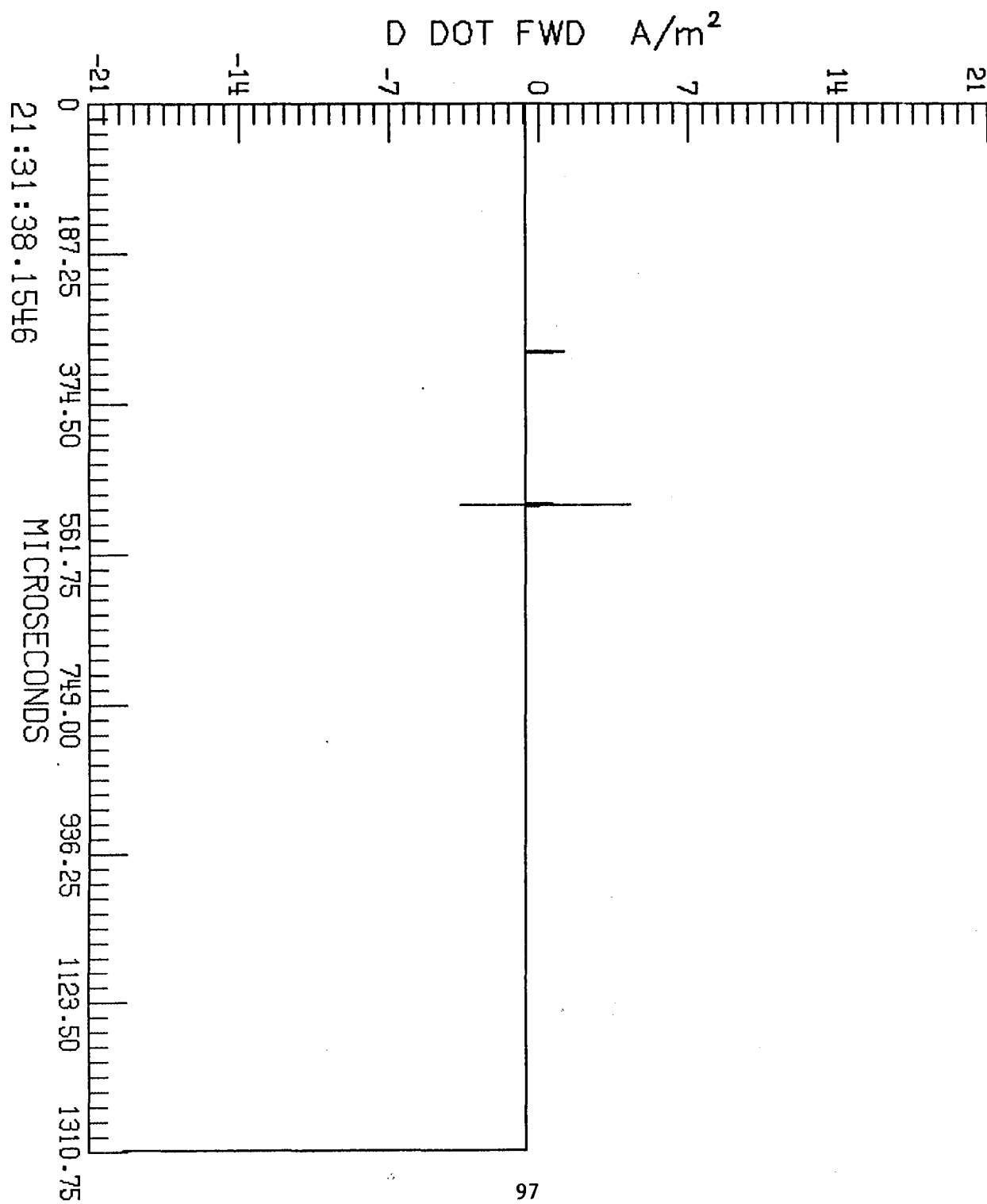
TEST NO. 83-

RUN NO. 3 N-003



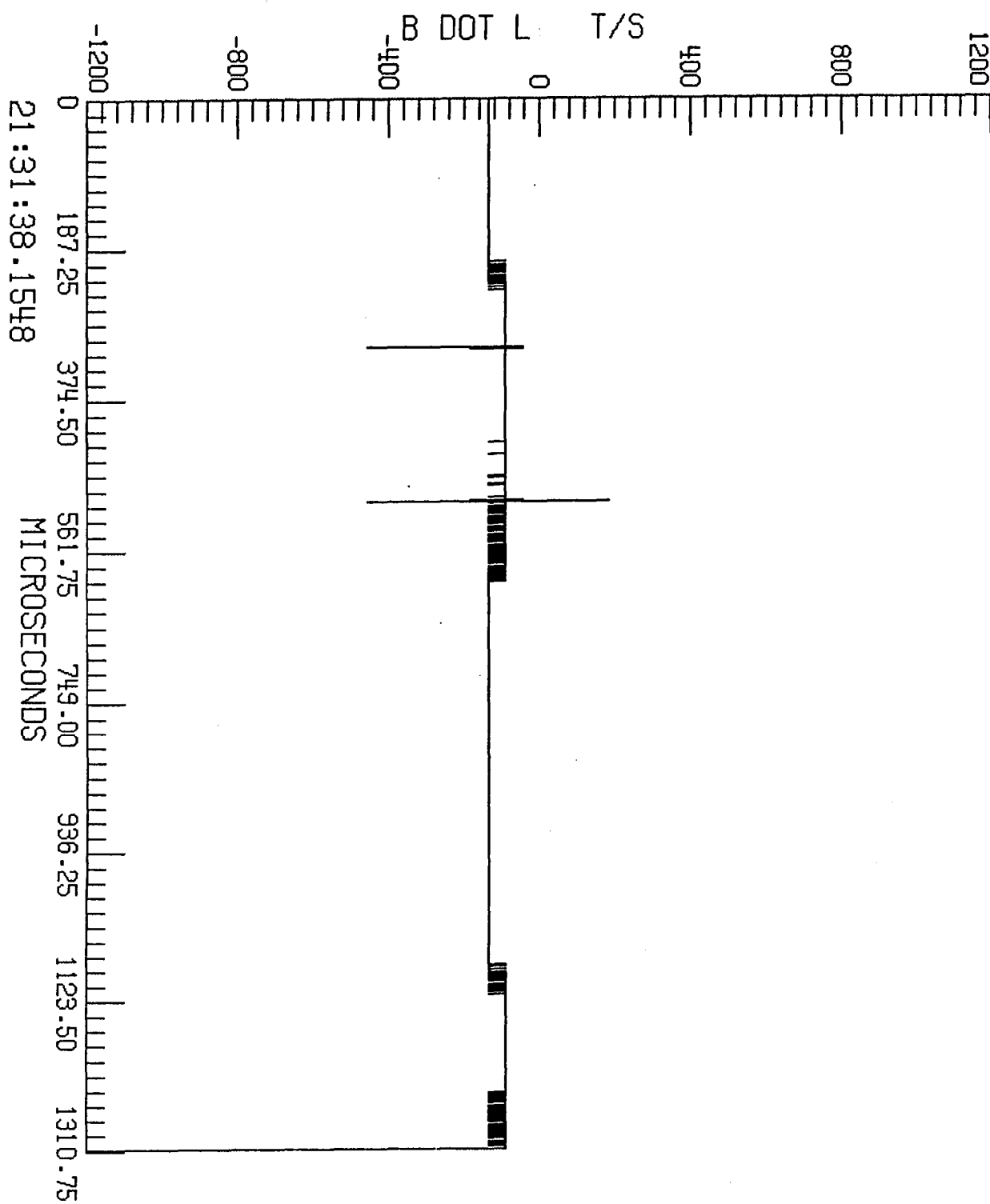
F106 LIGHTNING TK 8/THOMAS
RUN NO. 1 N-001

TEST NO. 83-C



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 1 N-001

TEST NO. 83-

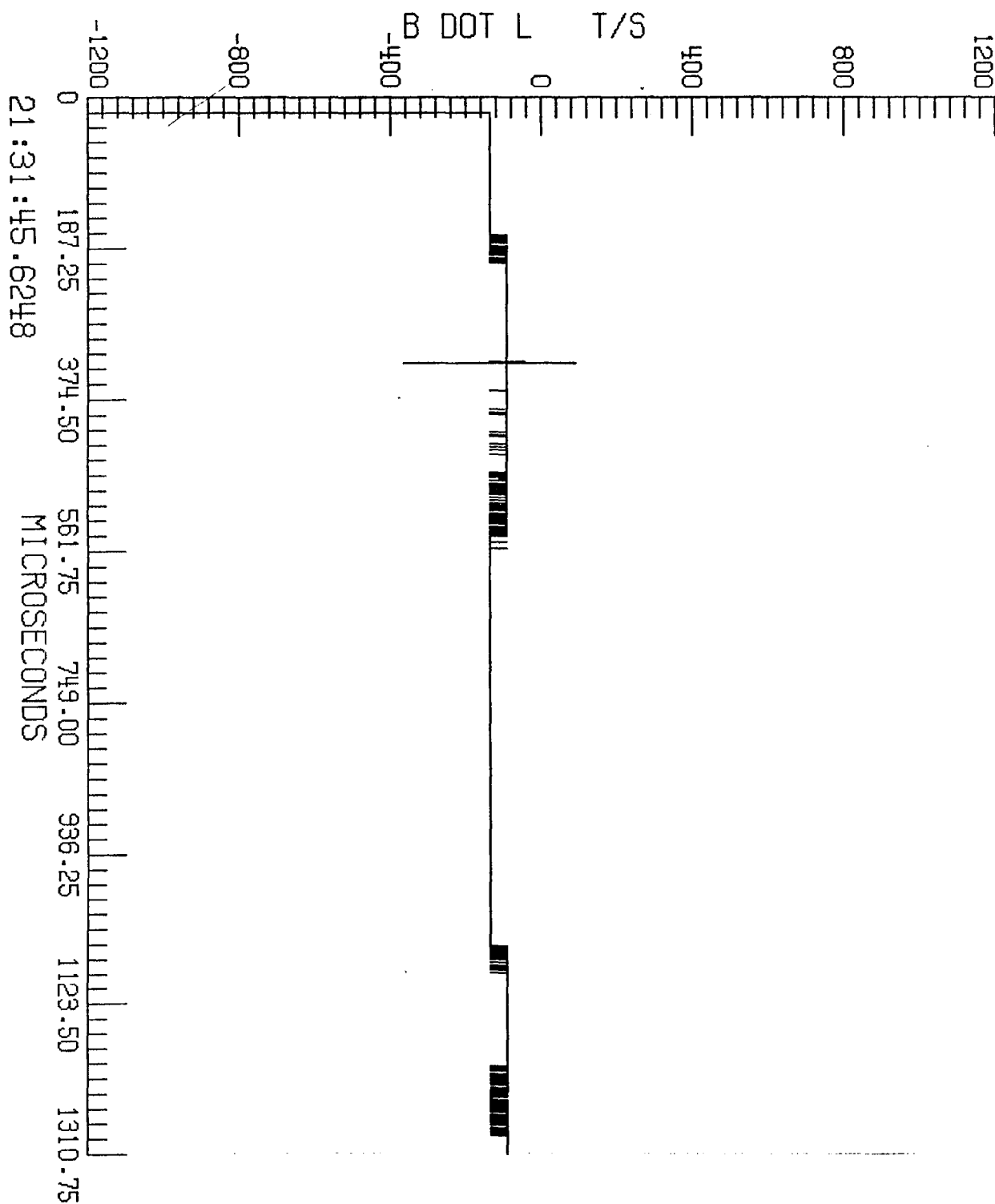


F106 LIGHTNING/TK.10/M.THOMAS

TEST NO. 83-

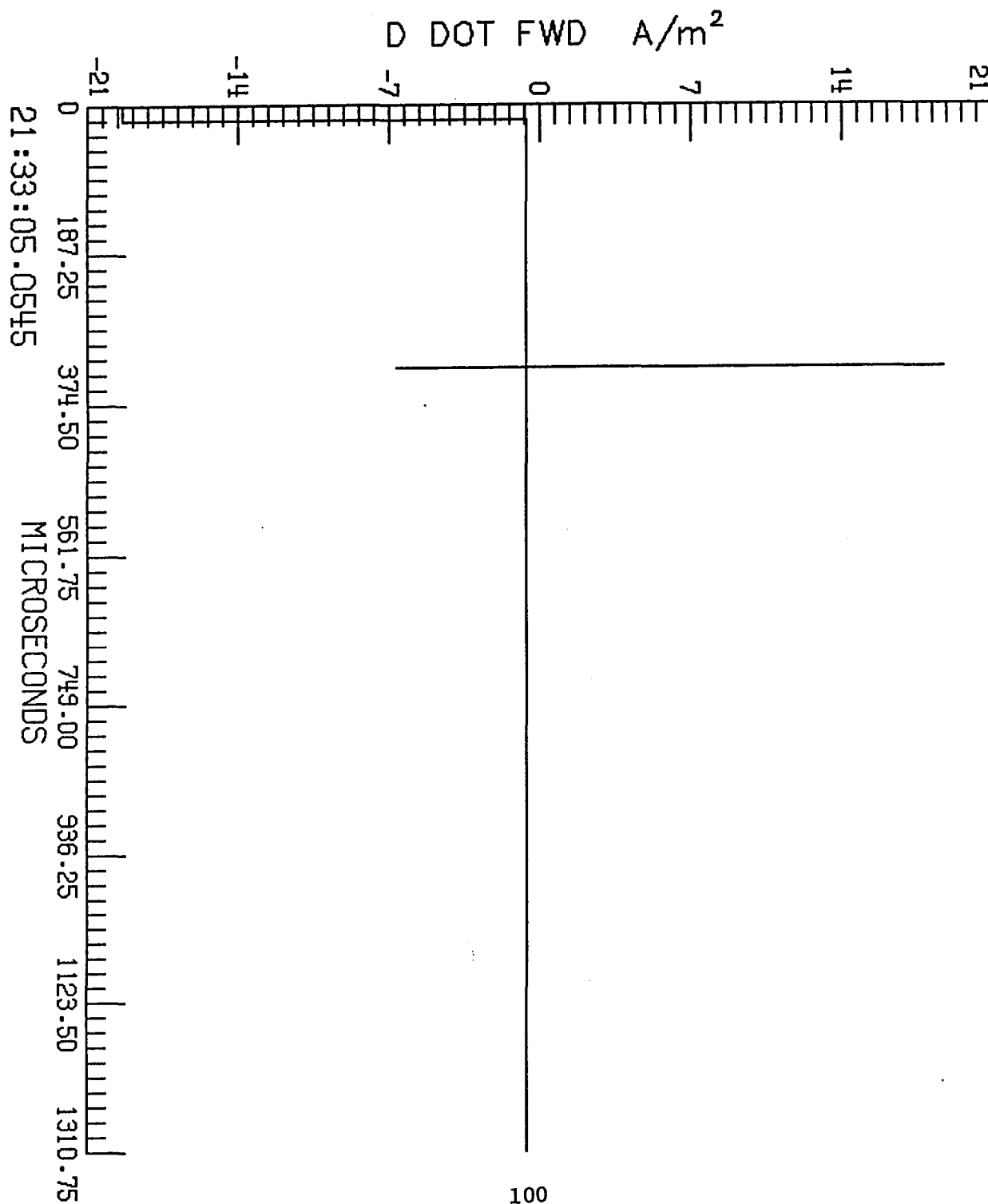
RUN NO. 2

N-002



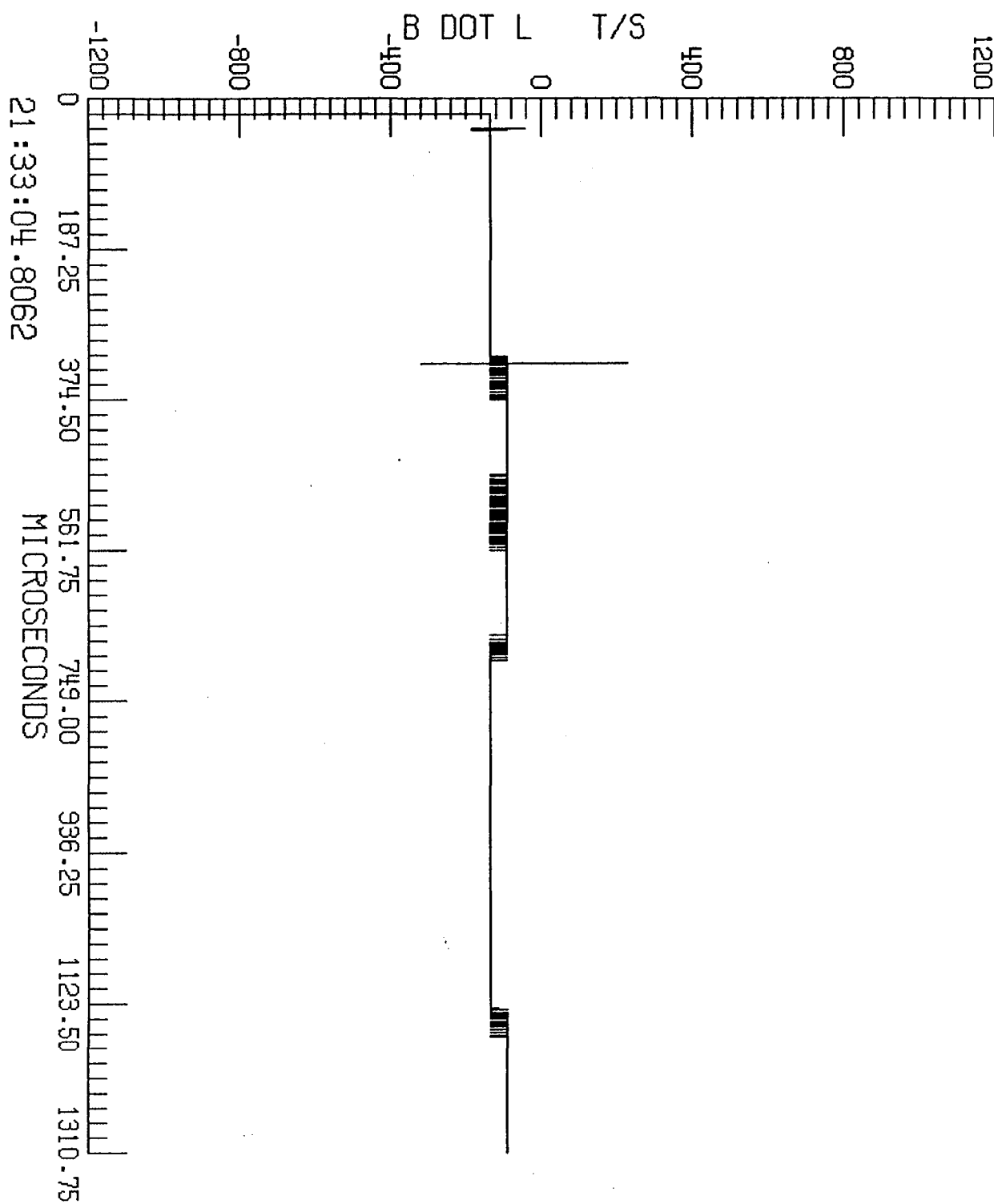
F106 LIGHTNING TK 8/THOMAS
RUN NO. 3 S-001

TEST NO. 83-C



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 3 S-001

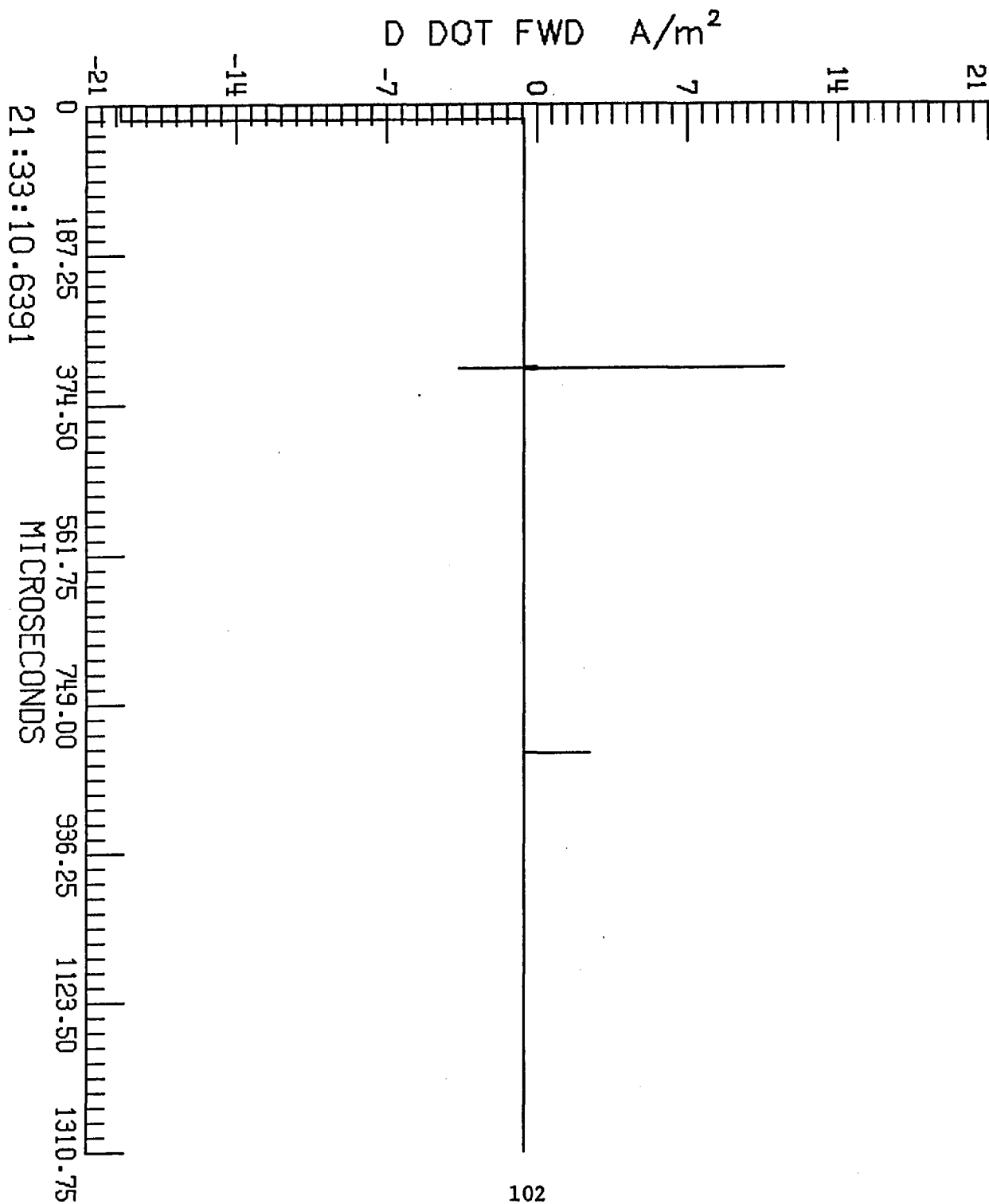
TEST NO. 83-



F106 LIGHTNING TK 8/THOMAS
RUN NO. 4

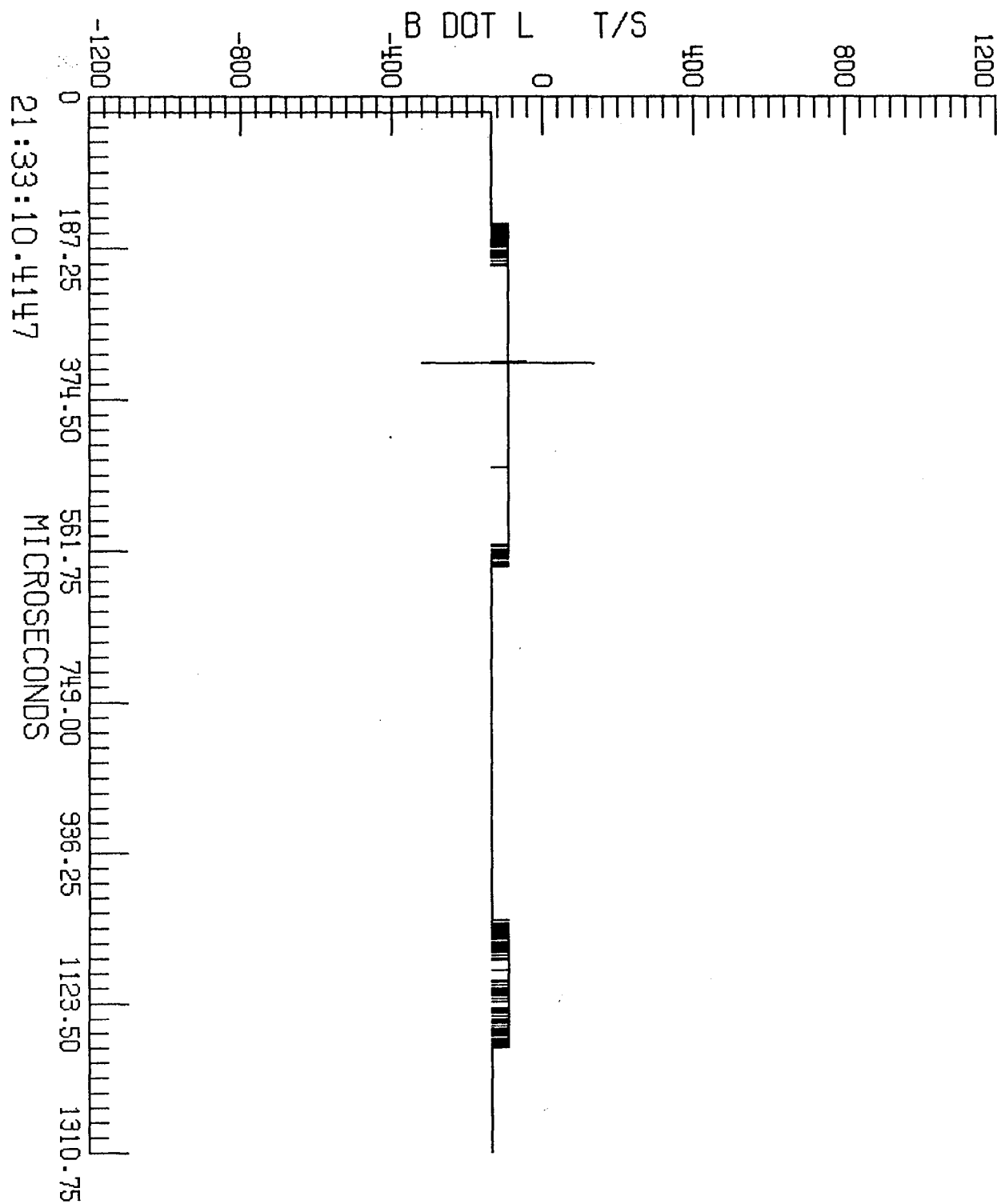
S-002

TEST NO. 83-0



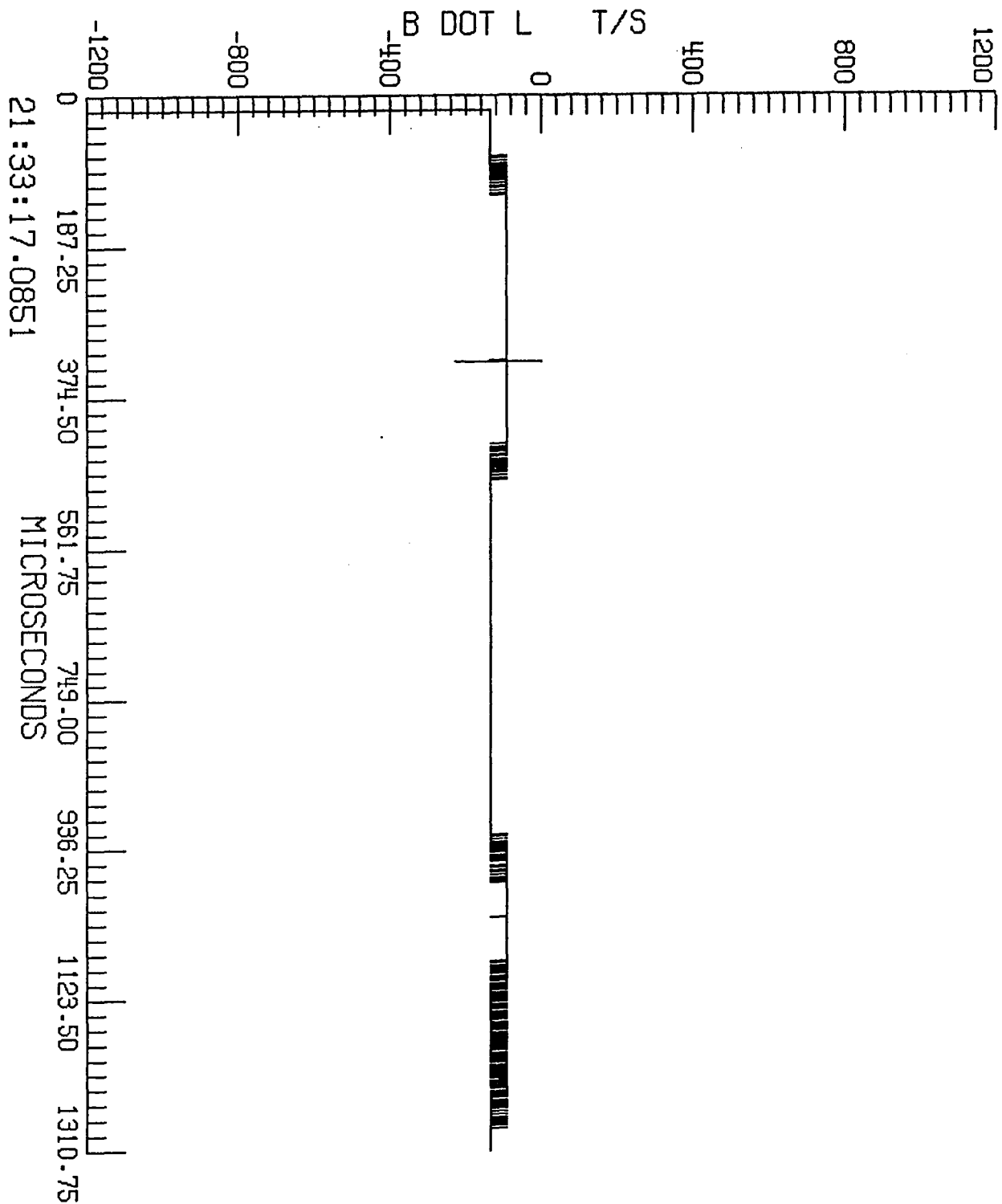
F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 4 S-002

TEST NO. 83-



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 5 S-003

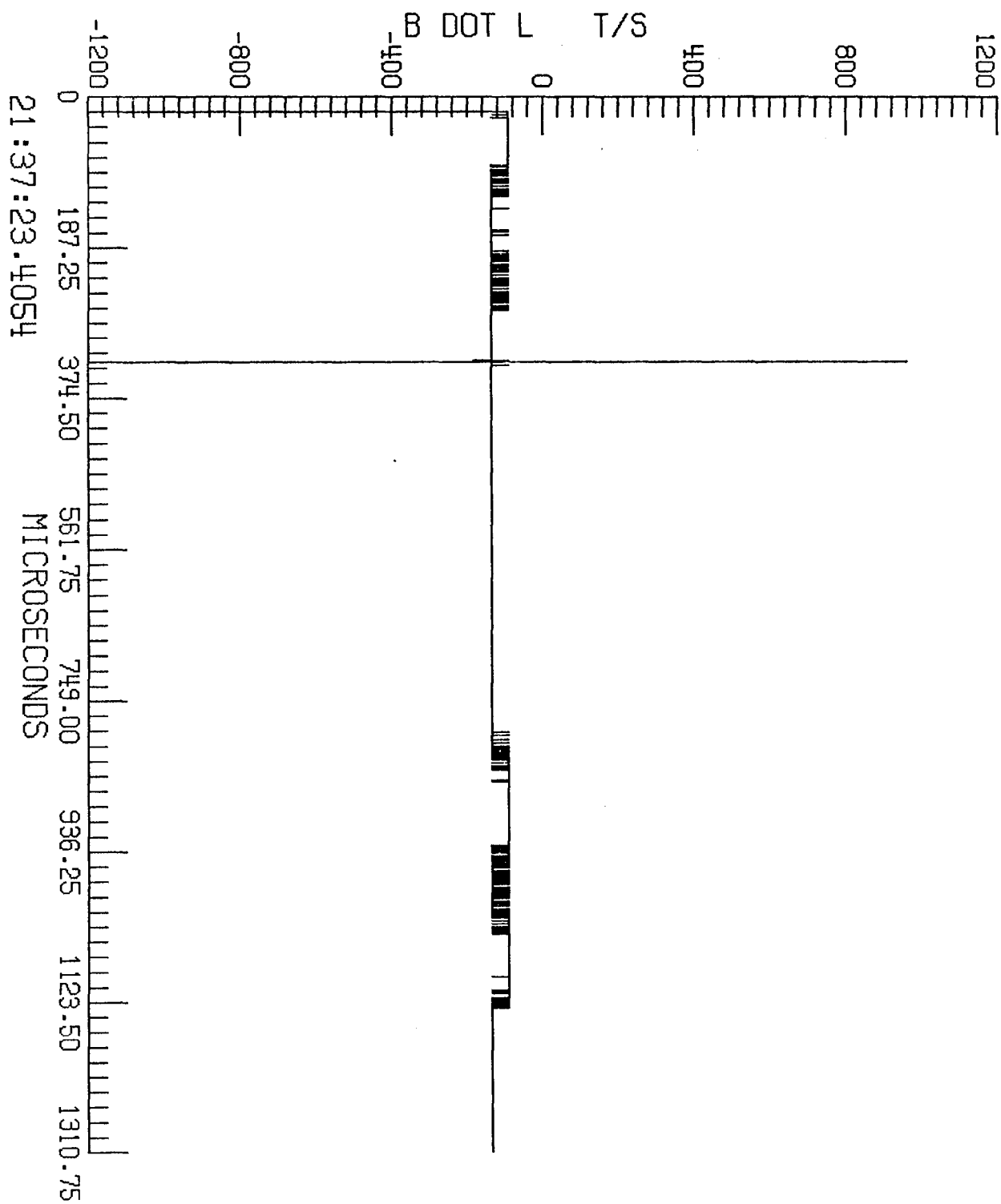
TEST NO. 83



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 6

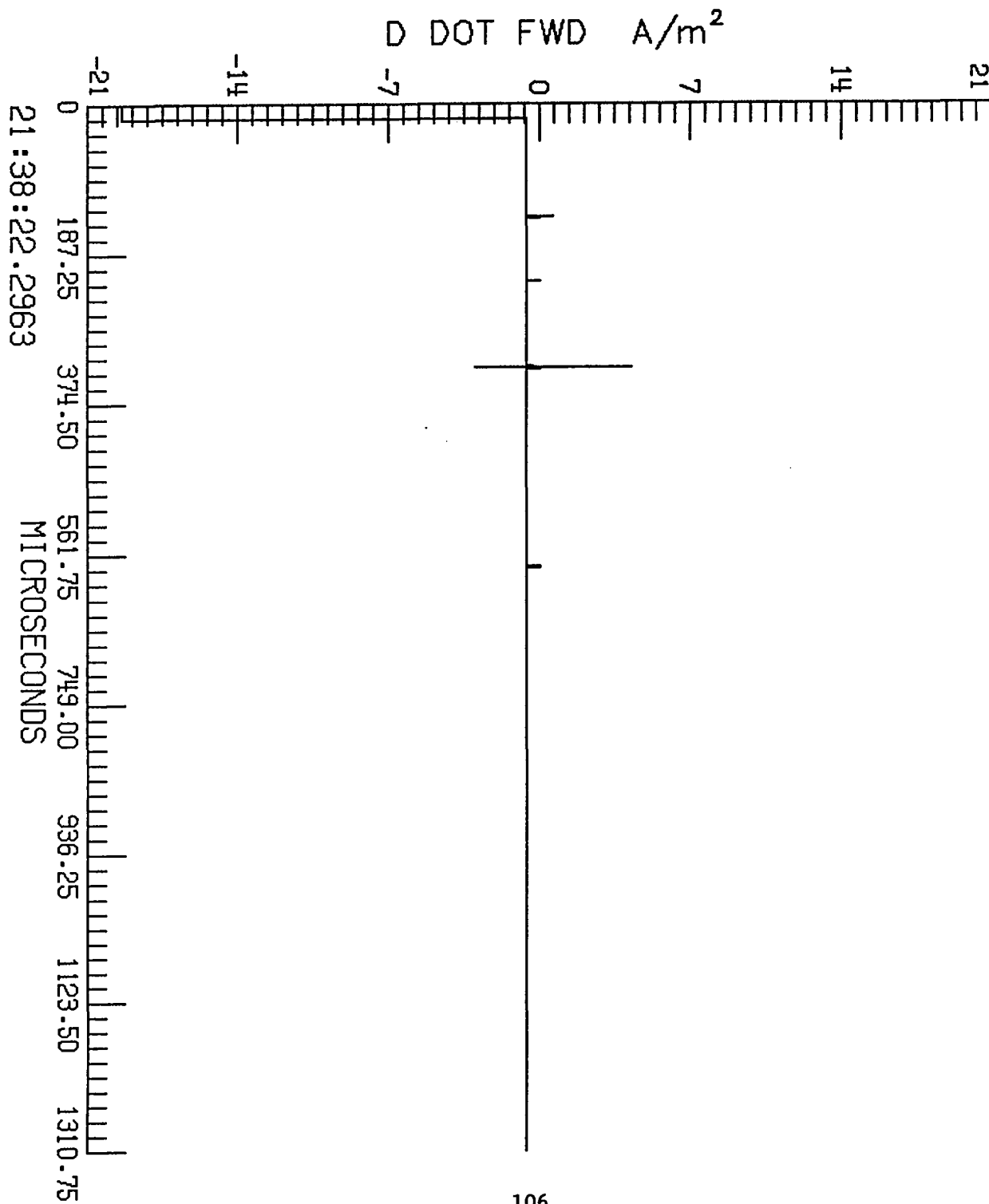
S-004

TEST NO. 83-



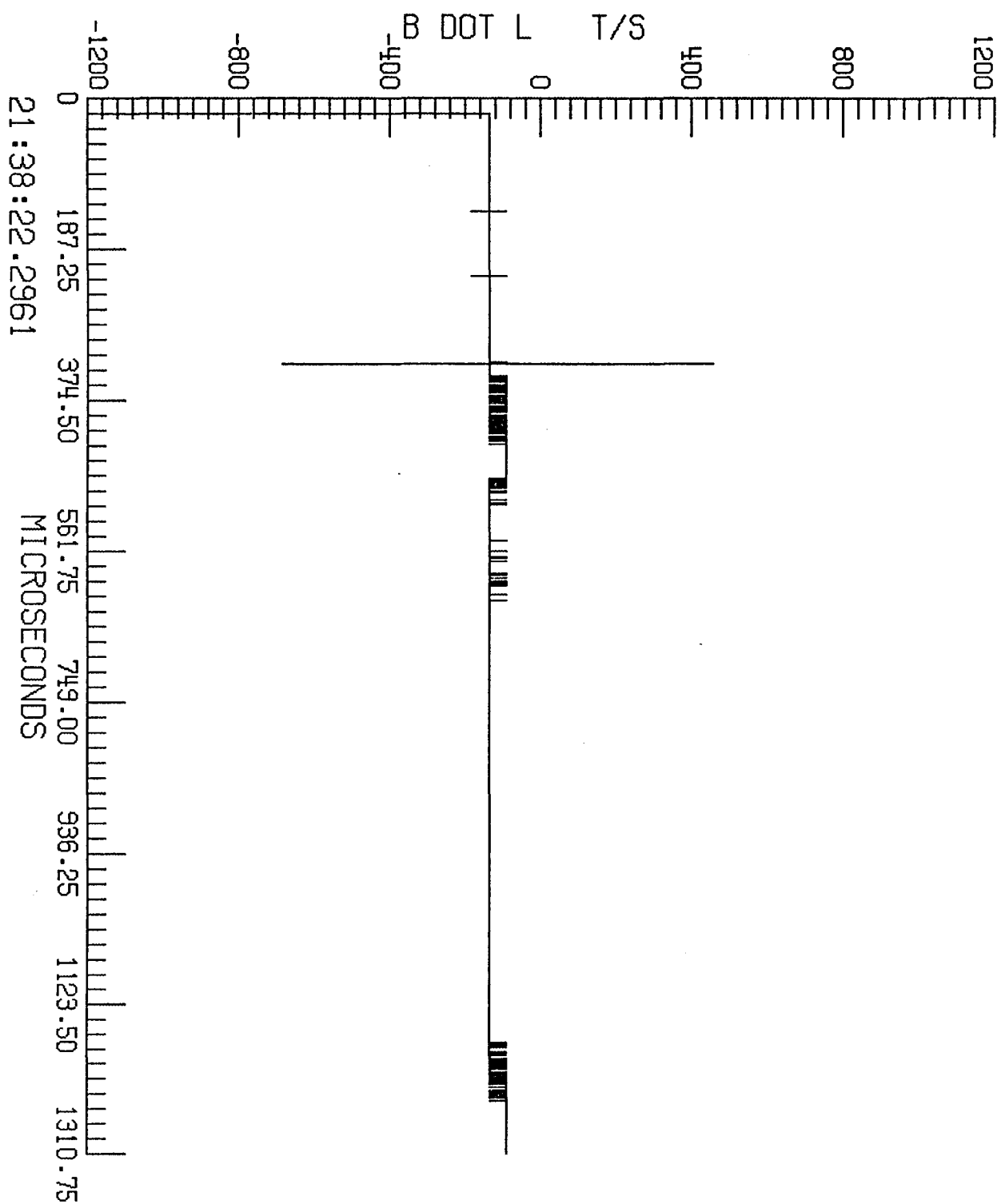
F106 LIGHTNING TK 8/THOMAS
RUN NO. 7

TEST NO. 83-0



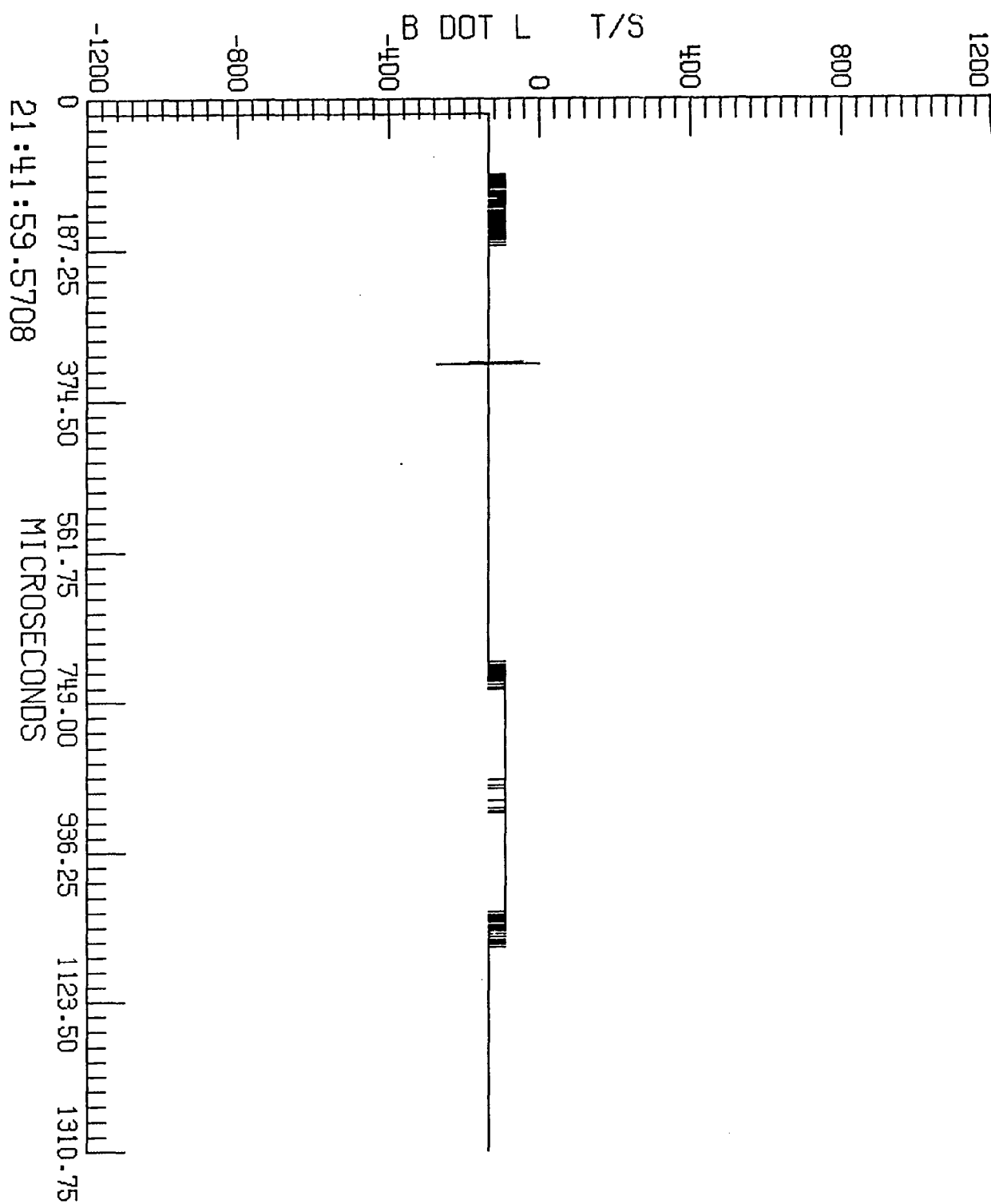
F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 7 N-003

TEST NO. 83



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 8 N-004

TEST NO. 83-

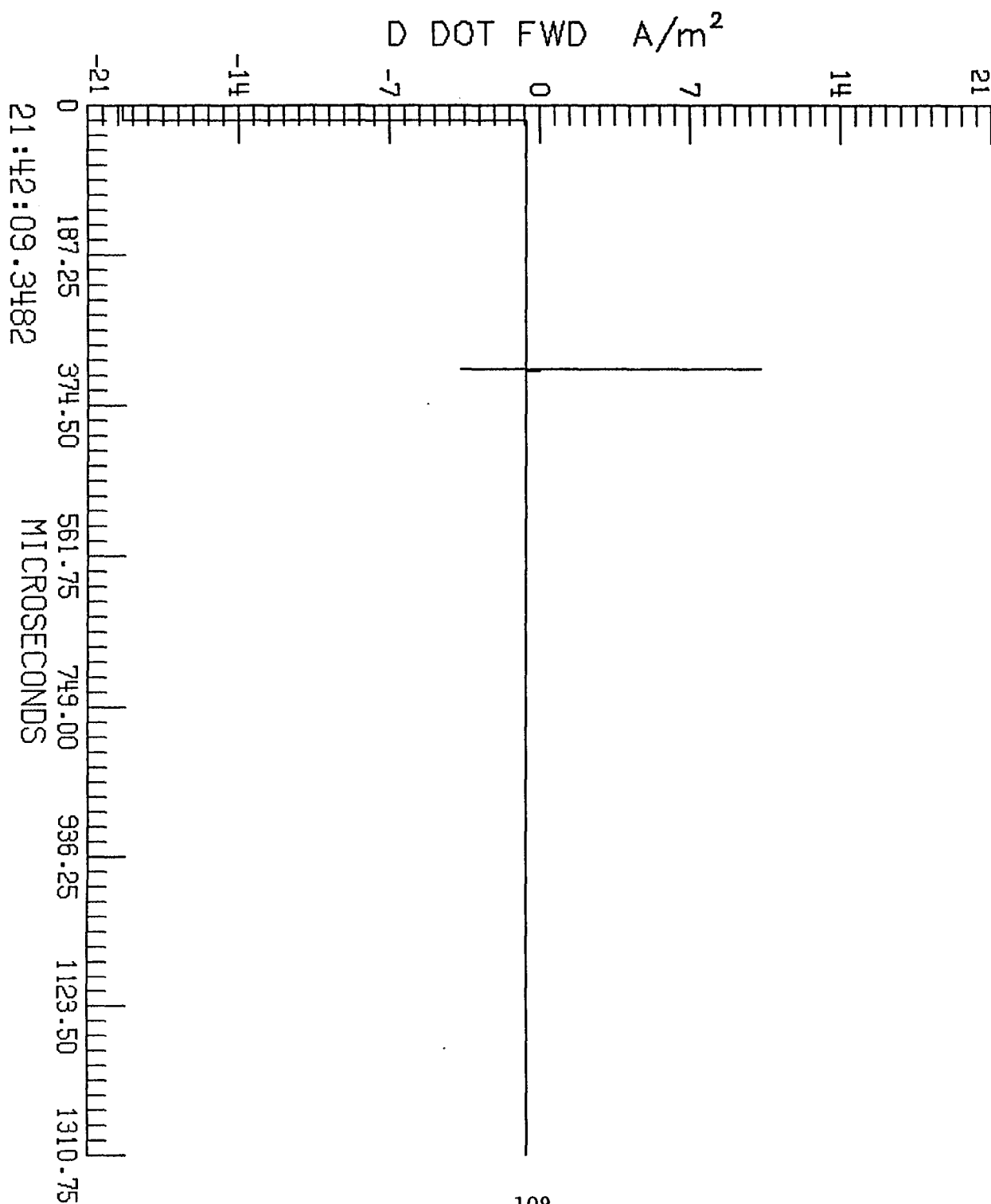


F106 LIGHTNING TK 8/THOMAS

TEST NO. 83-0

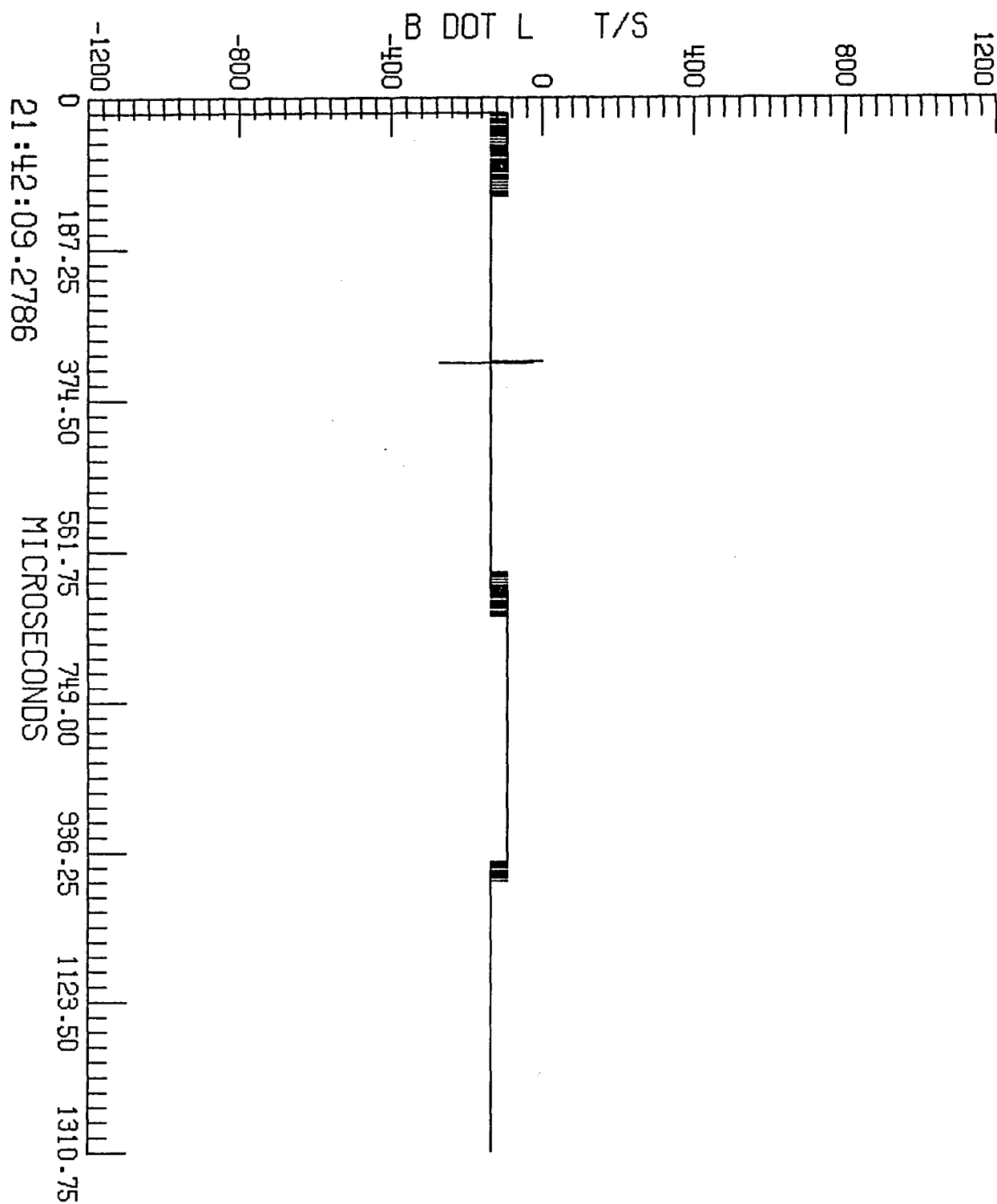
RUN NO. 9

S-005



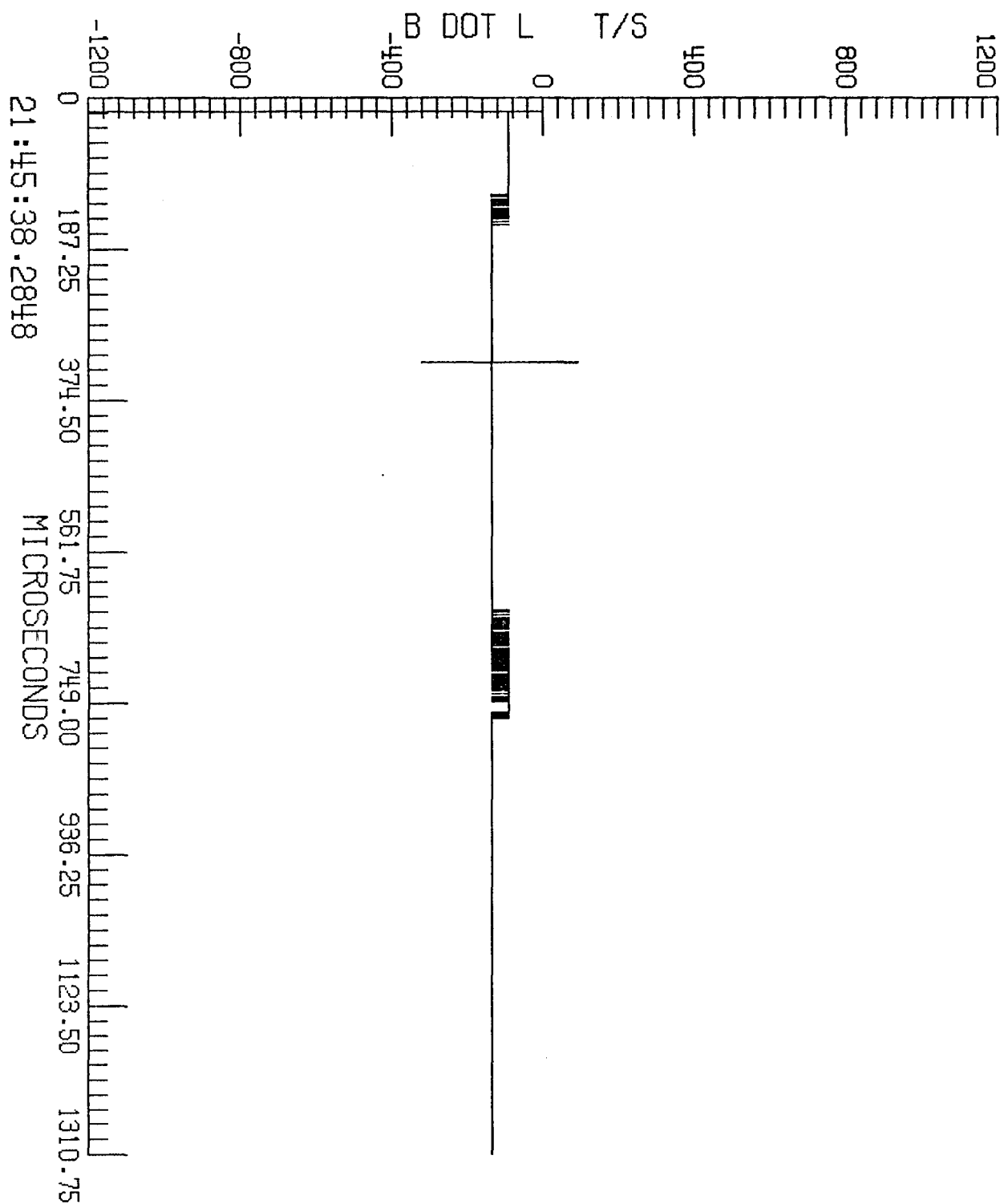
F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 9 S-005

TEST NO. 83-



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 10 N-005

TEST NO. 83-

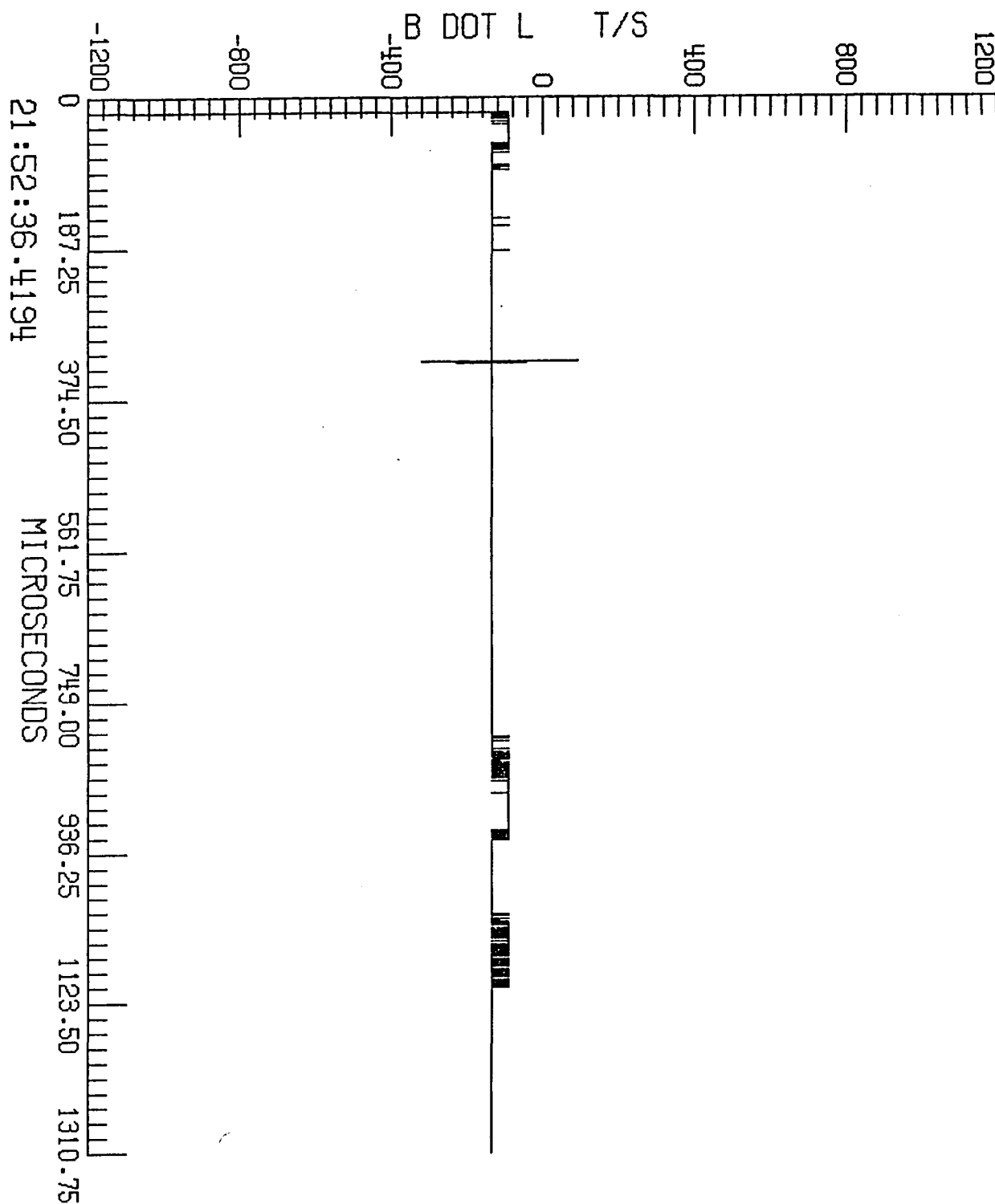


F106 LIGHTNING/TK.10/M.THOMAS

TEST NO. 83-

RUN NO. 11

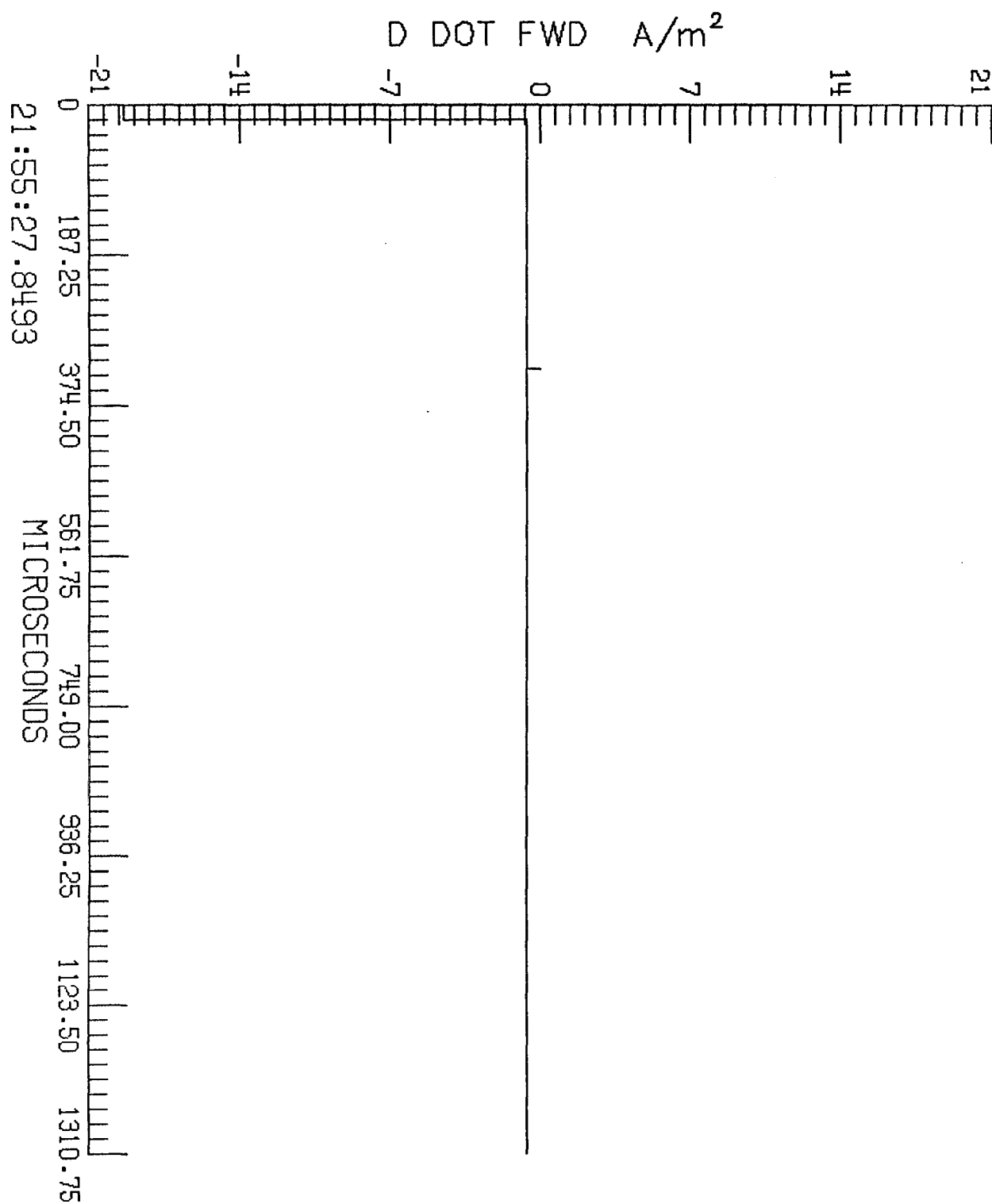
N-006



F106 LIGHTNING TK 8/THOMAS
RUN NO. 12

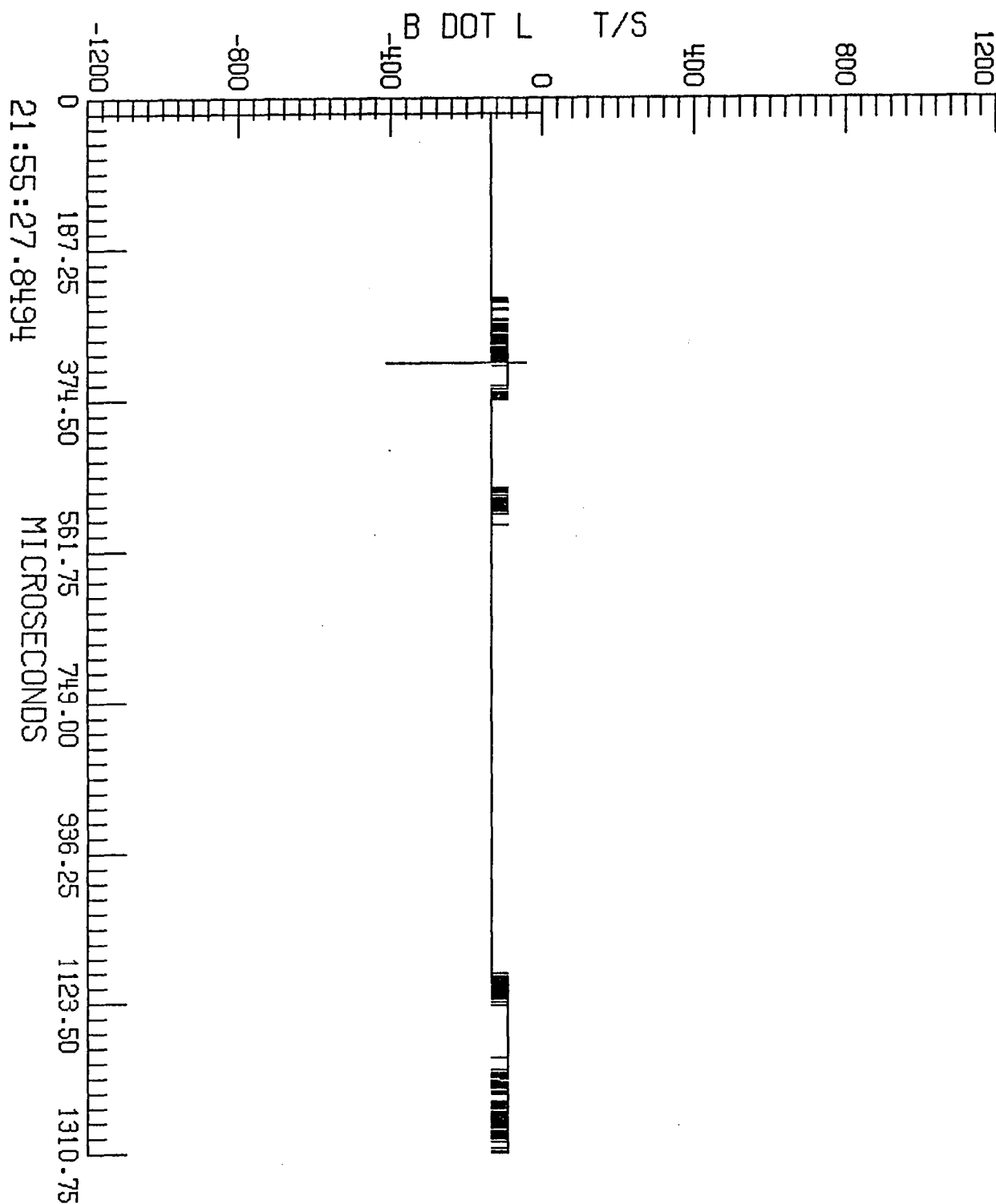
N-007

TEST NO. 83-0



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 12 N-007

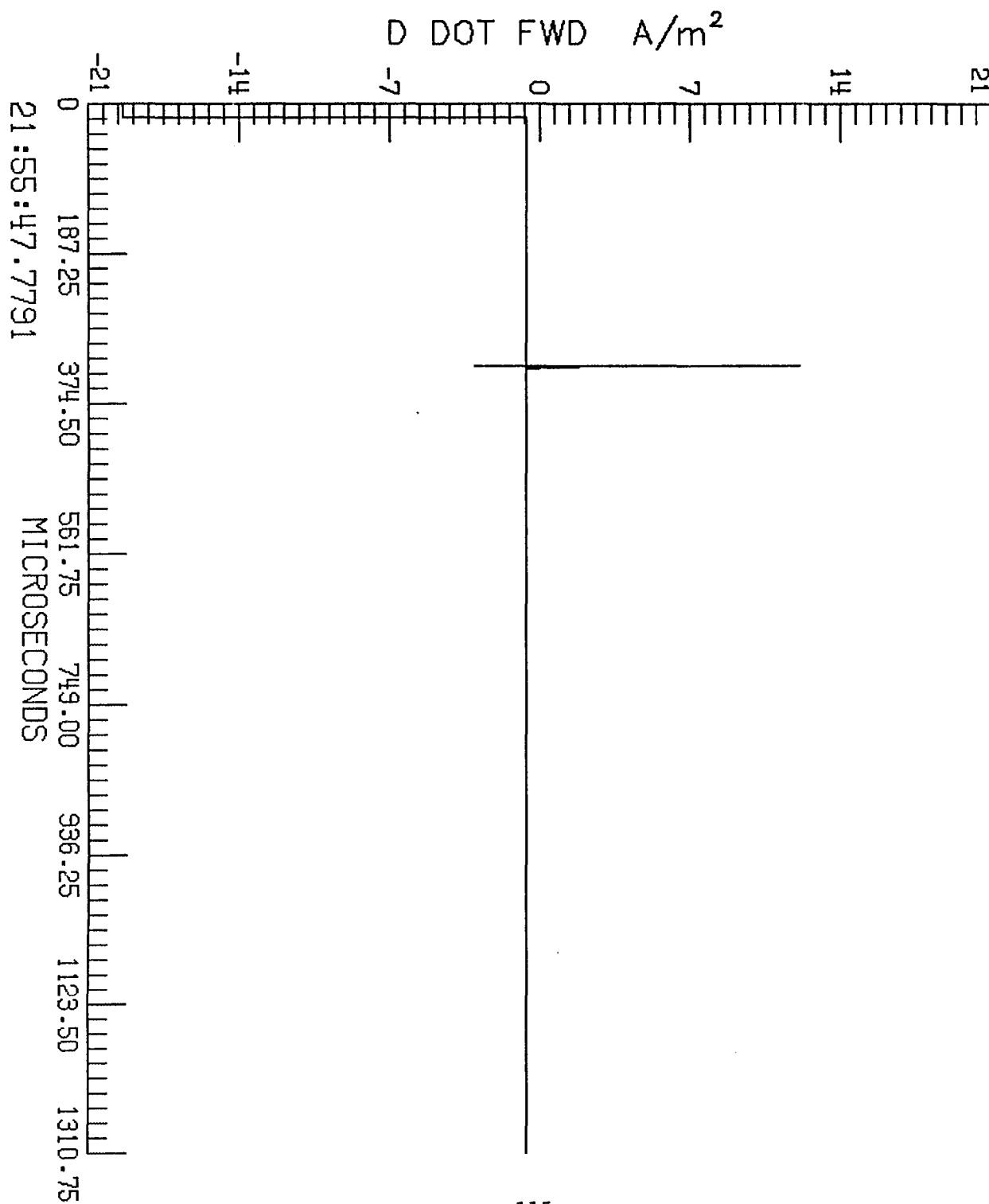
TEST NO. 83-



F106 LIGHTNING TK 8/THOMAS
RUN NO. 13

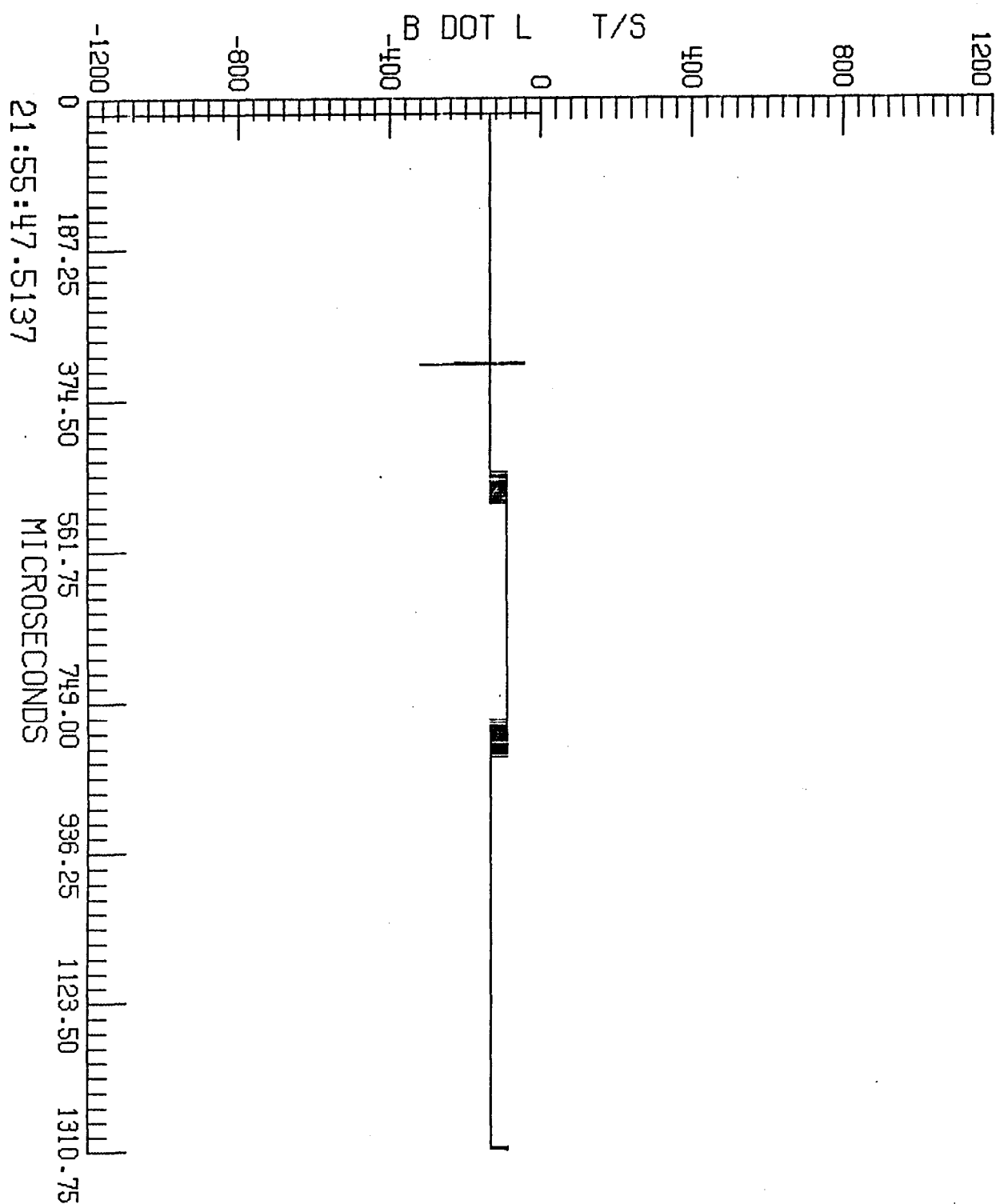
TEST NO. 83-0

N-008



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 13 N-008

TEST NO. 83-

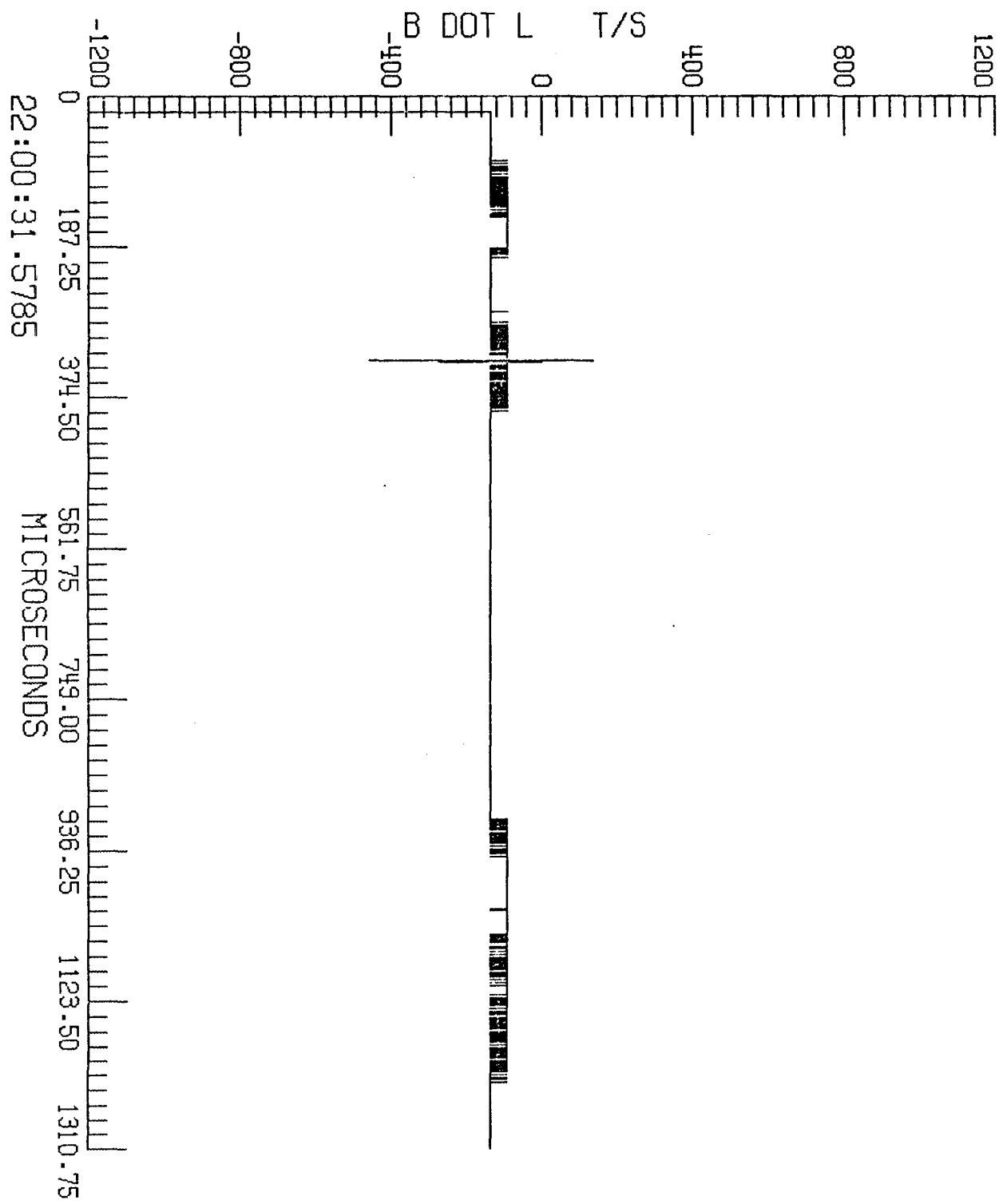


F106 LIGHTNING/TK.10/M.THOMAS

TEST NO. 83-

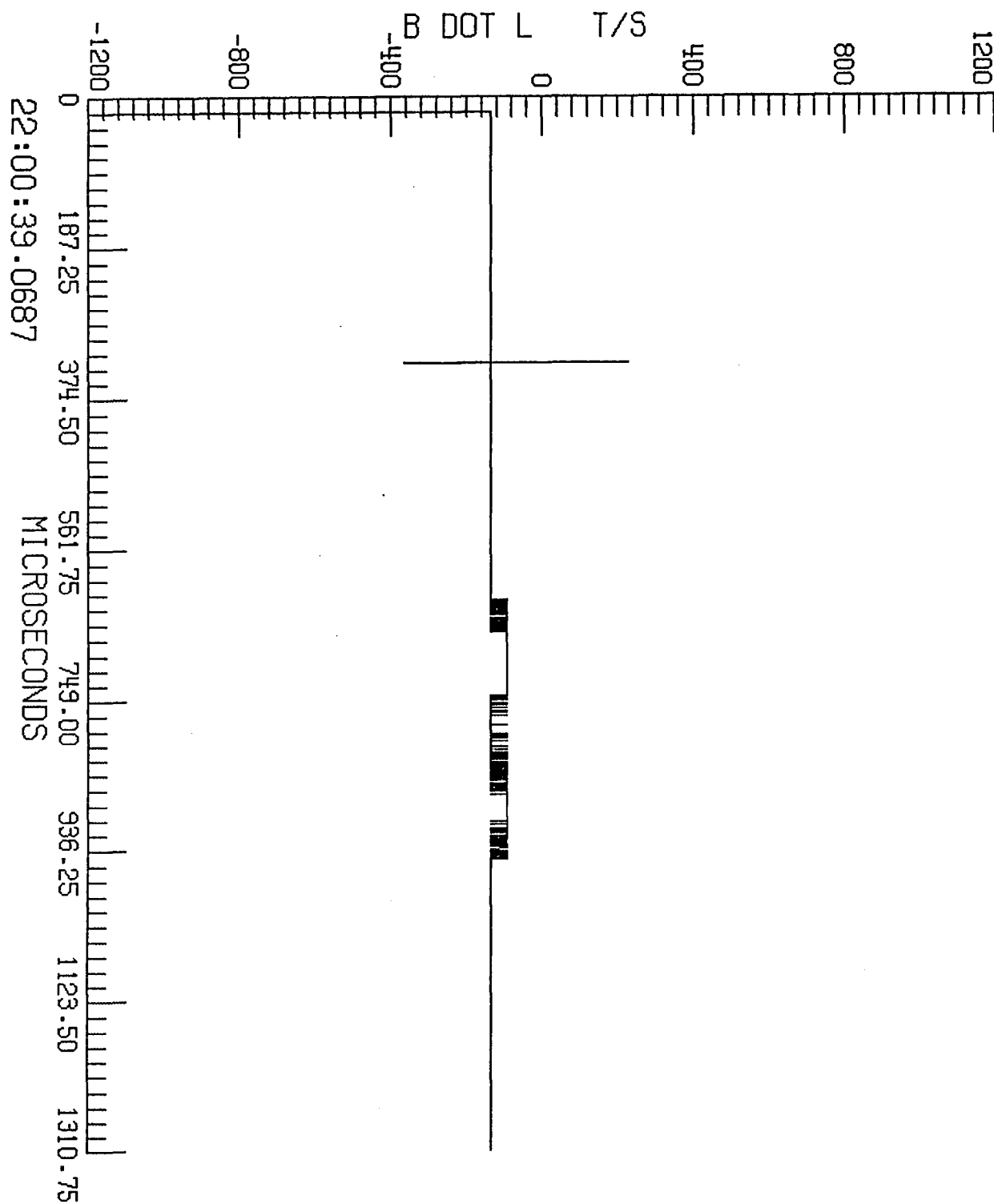
RUN NO. 14

S-007



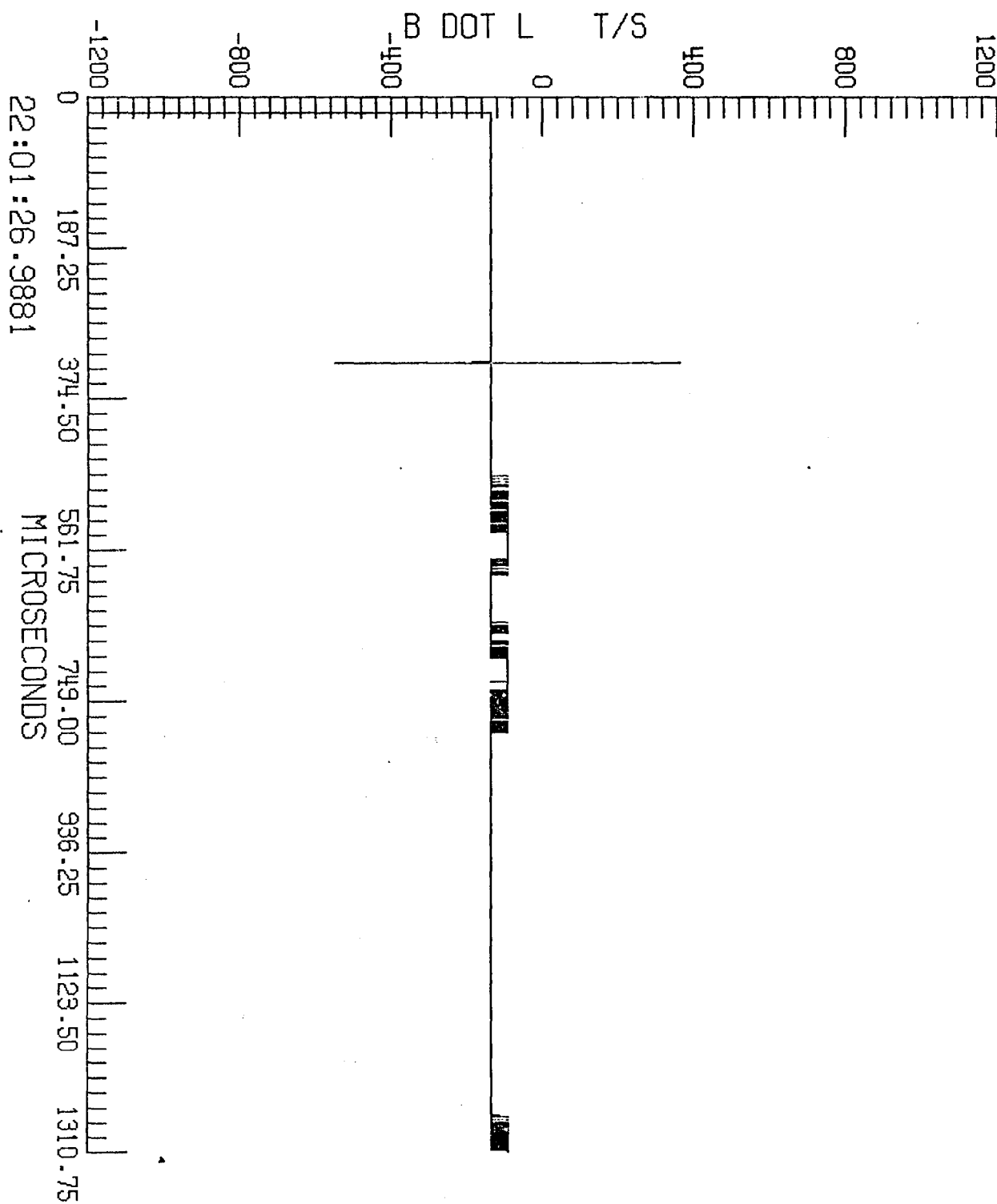
F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 15 N-009

TEST NO. 83-1



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 16 N-010

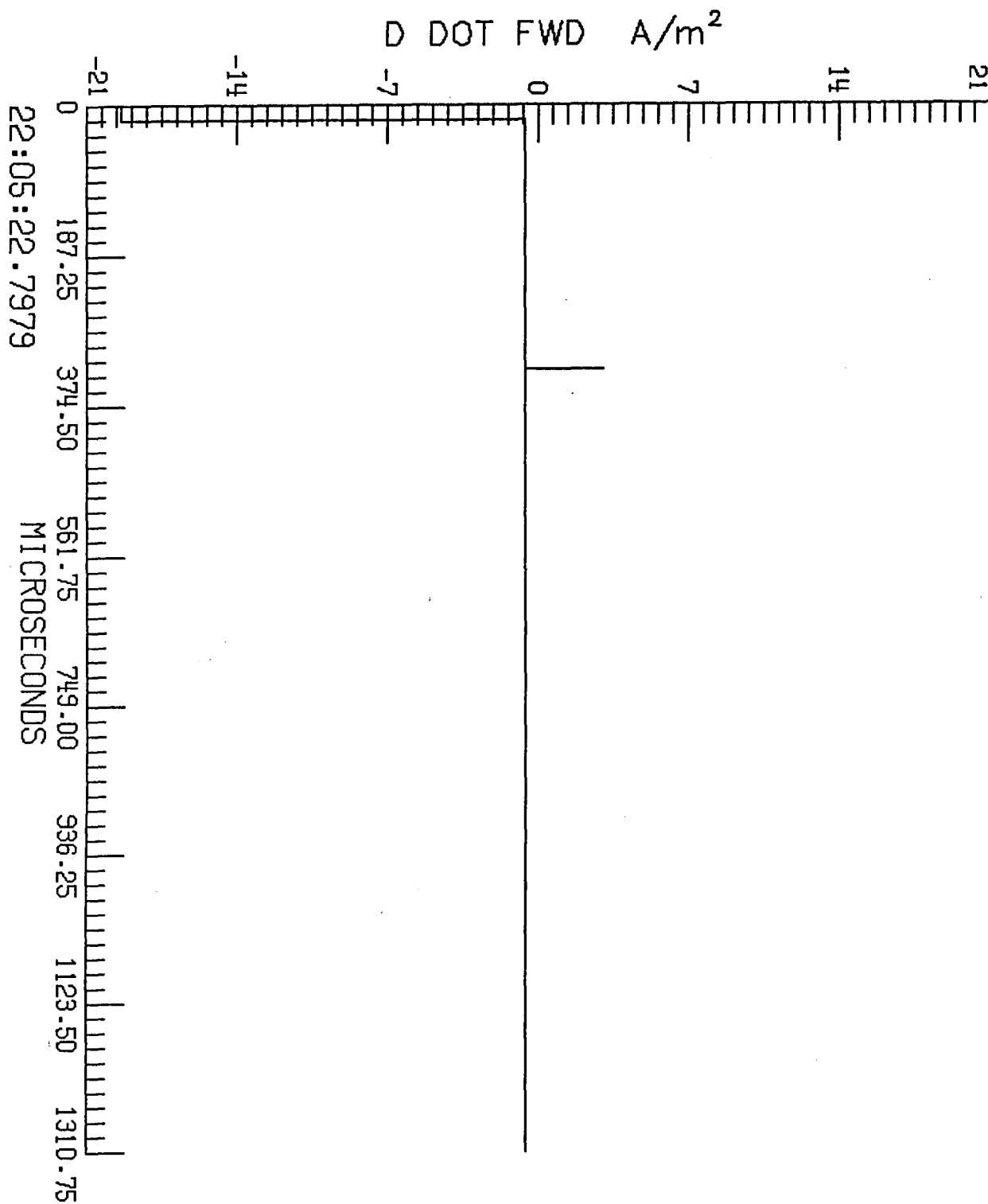
TEST NO. 83-



F106 LIGHTNING TK 8/THOMAS
RUN NO. 17

S-008

TEST NO. 83-0

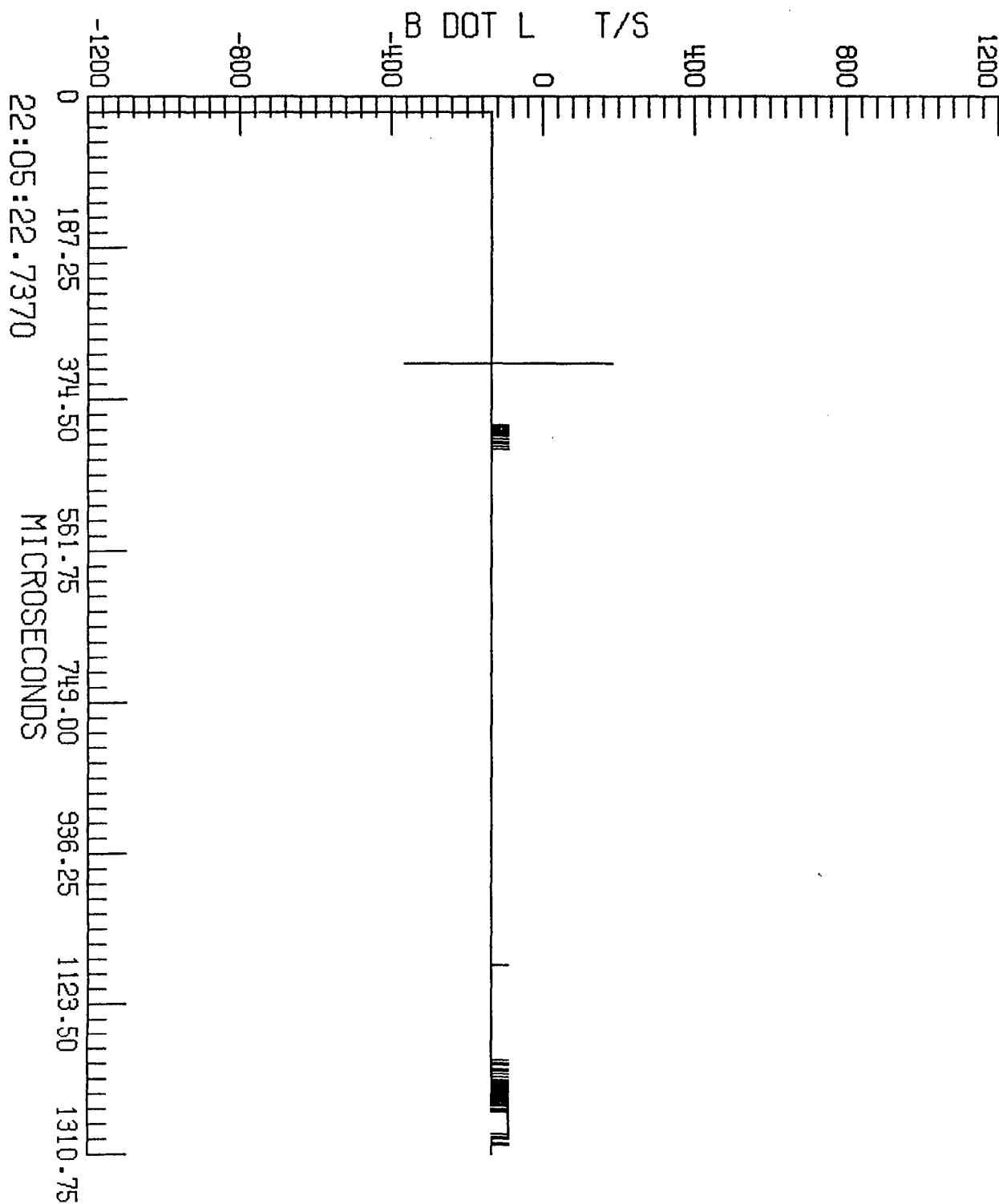


F106 LIGHTNING/TK.10/M.THOMAS

TEST NO. 83-

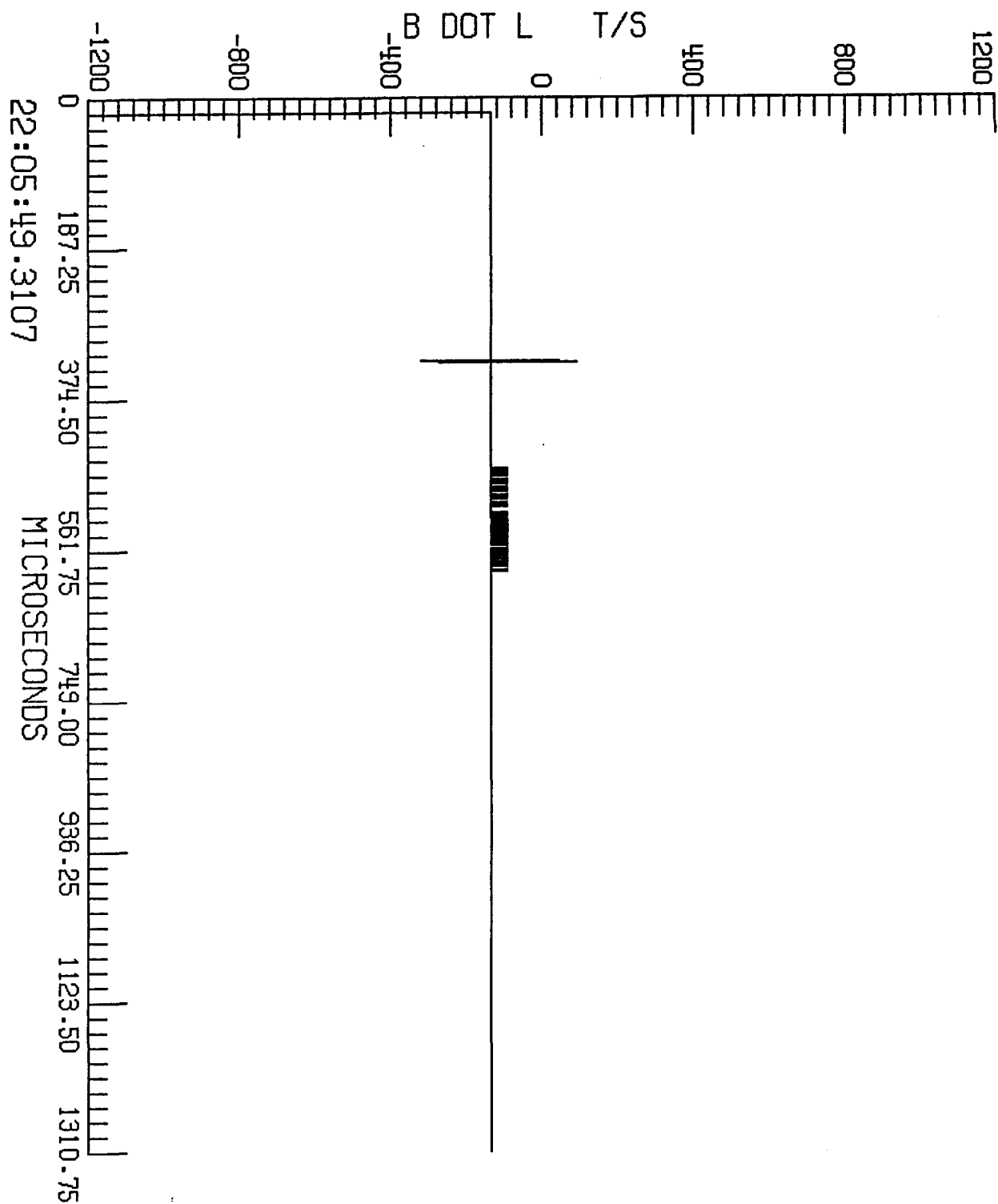
RUN NO. 17

S-008



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 18 N-011

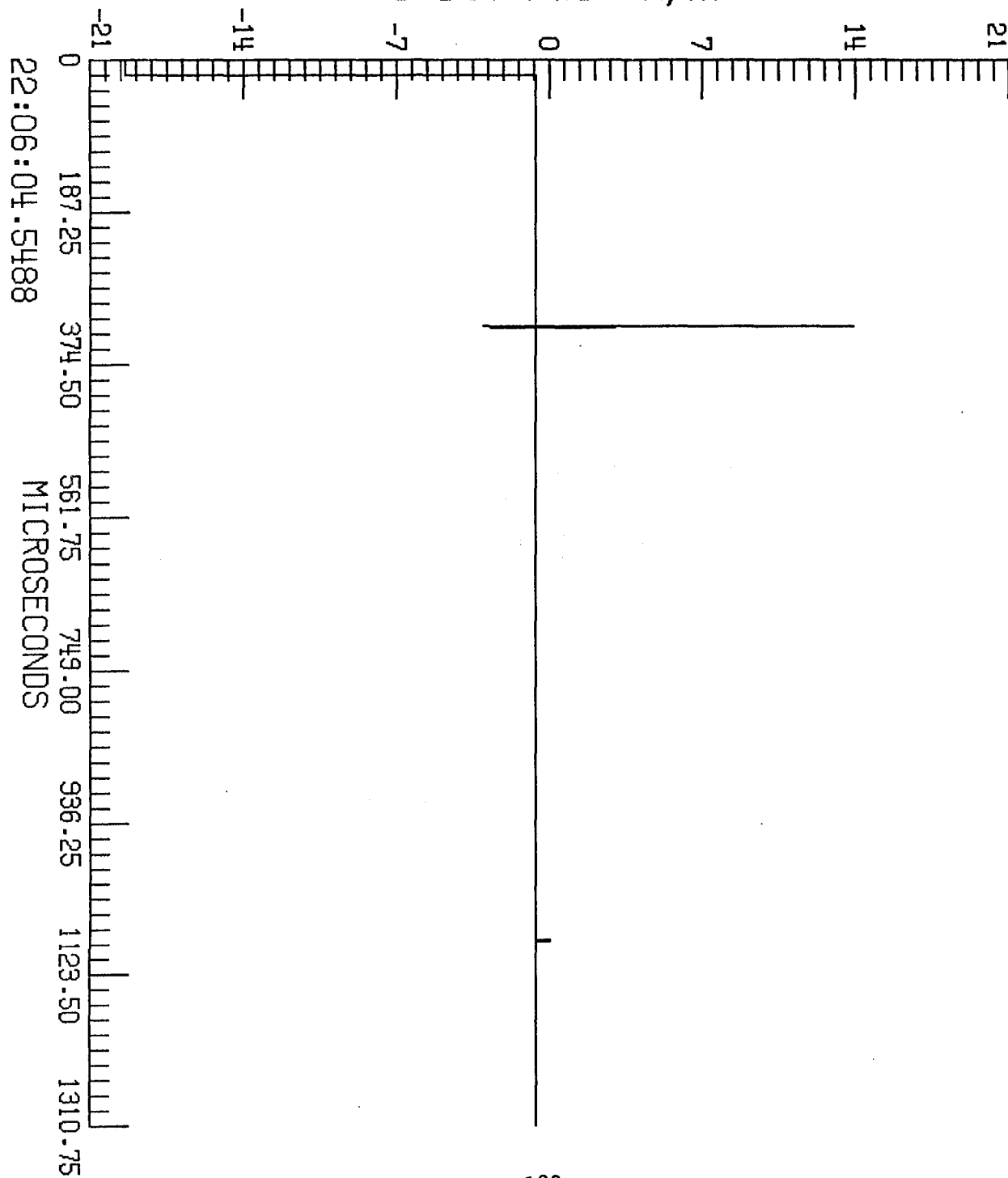
TEST NO. 83-



F106 LIGHTNING TK 8/THOMAS
RUN NO. 19

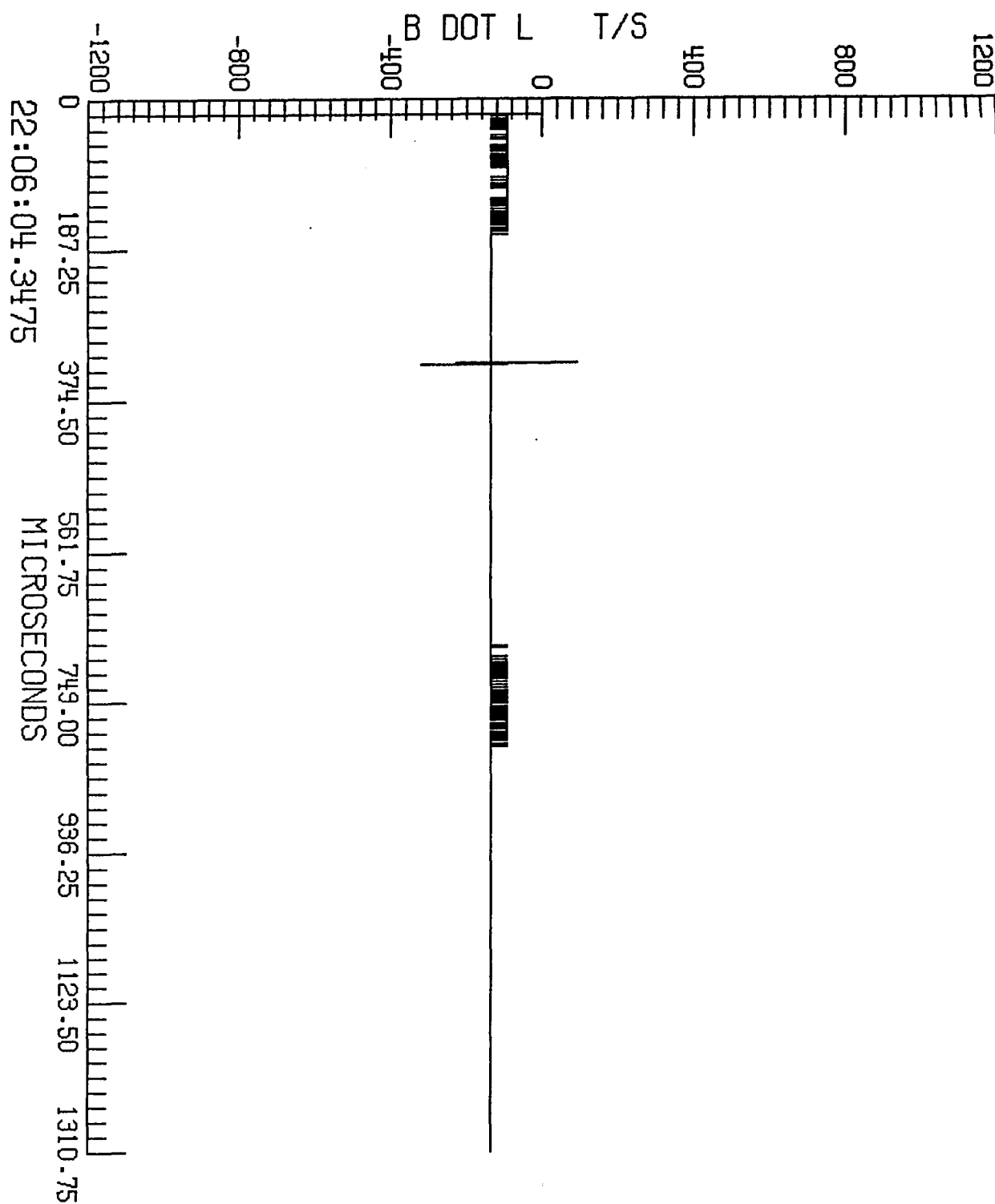
TEST NO. 83-0

D DOT FWD A/m^2



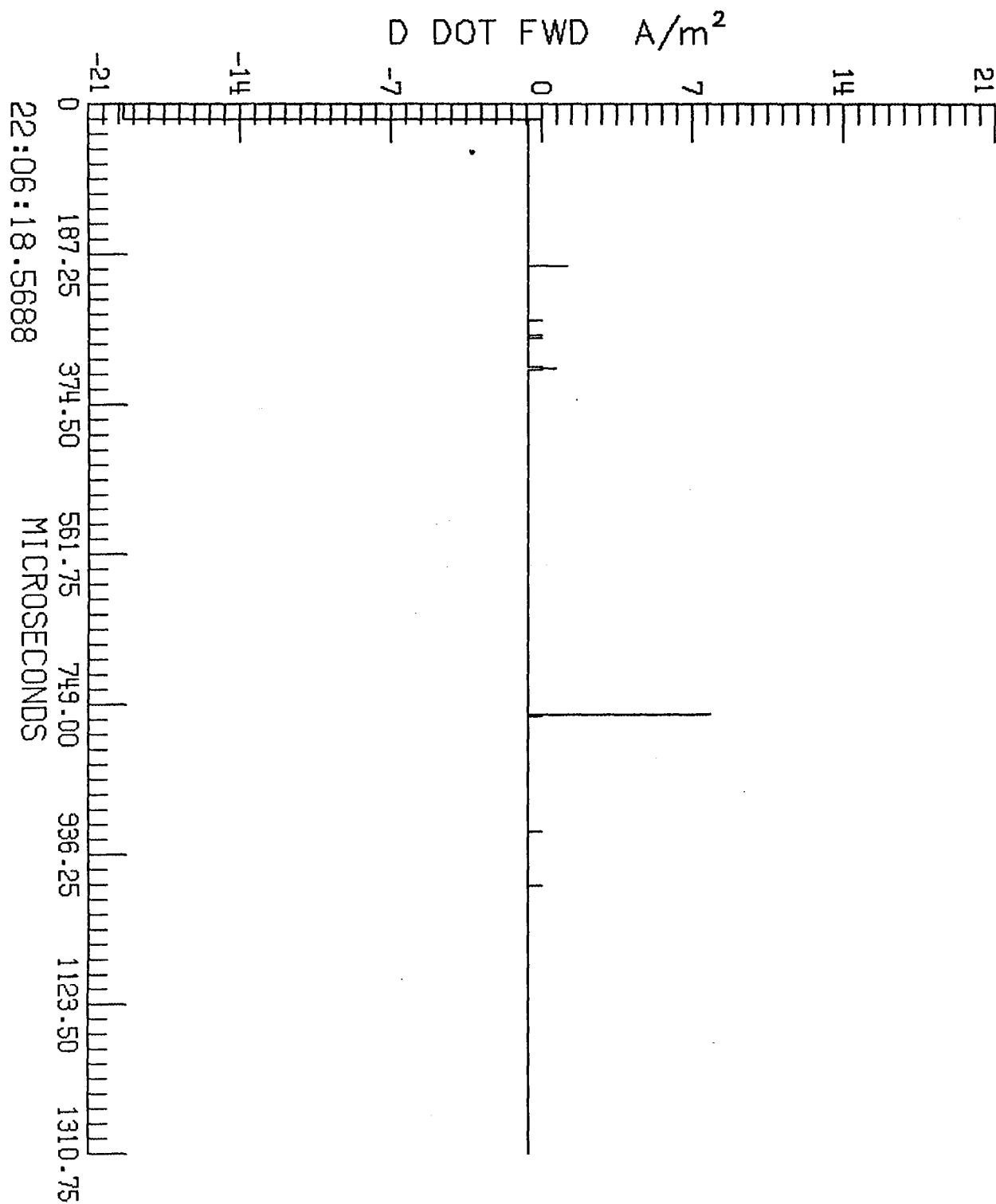
F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 19 S-009

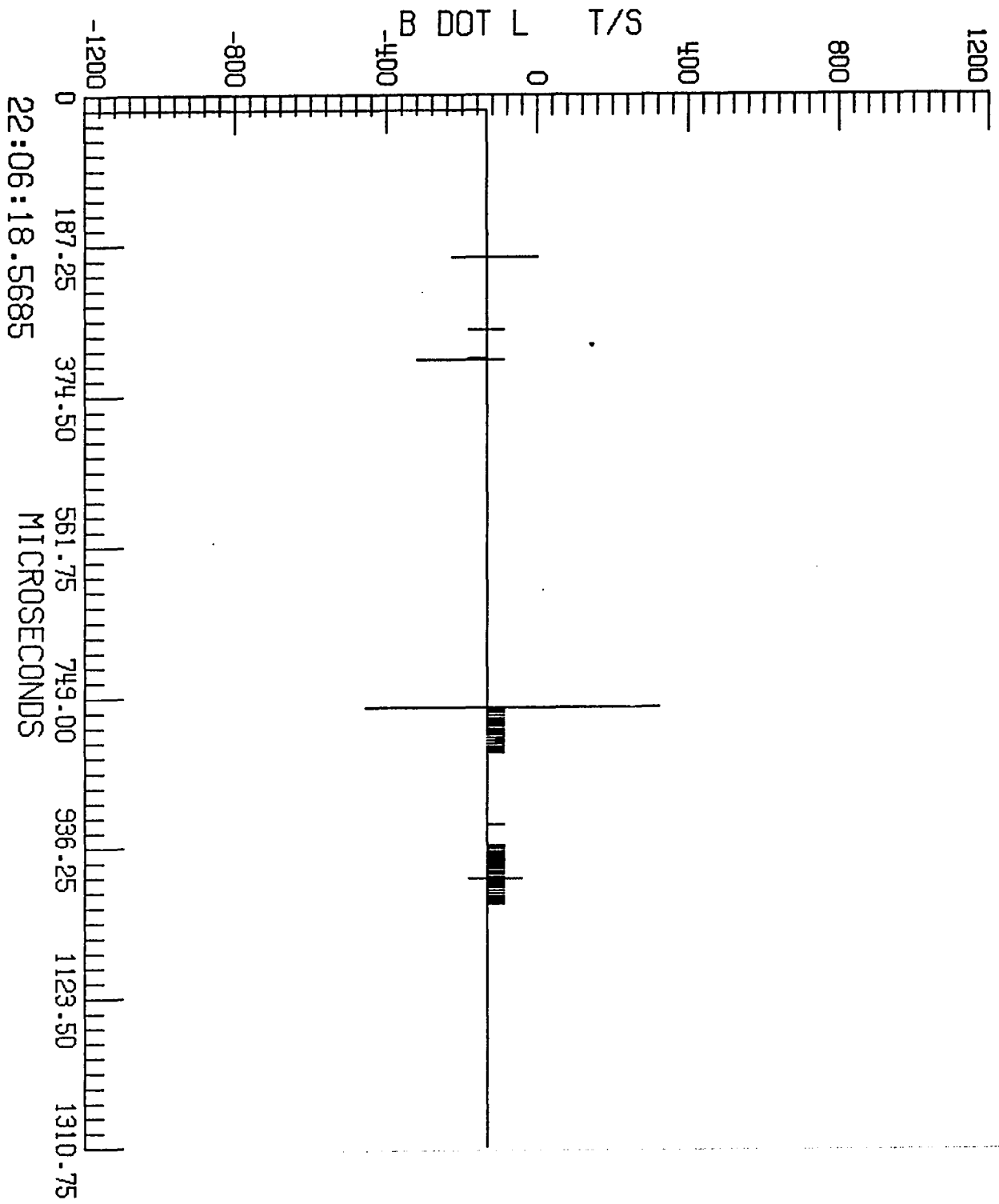
TEST NO. 83-



F106 LIGHTNING TK 8/THOMAS
RUN NO. 20 S-010

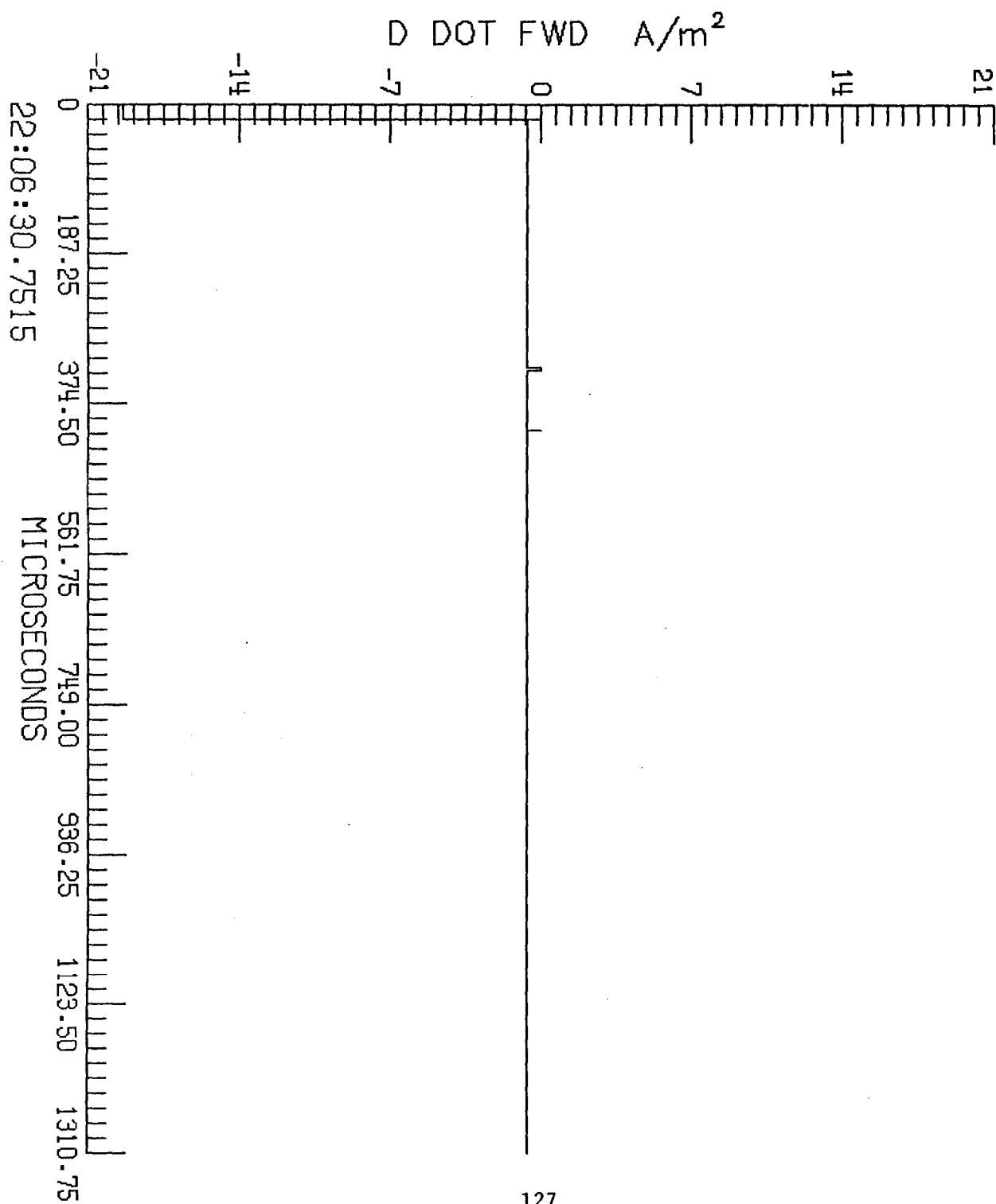
TEST NO. 83-0





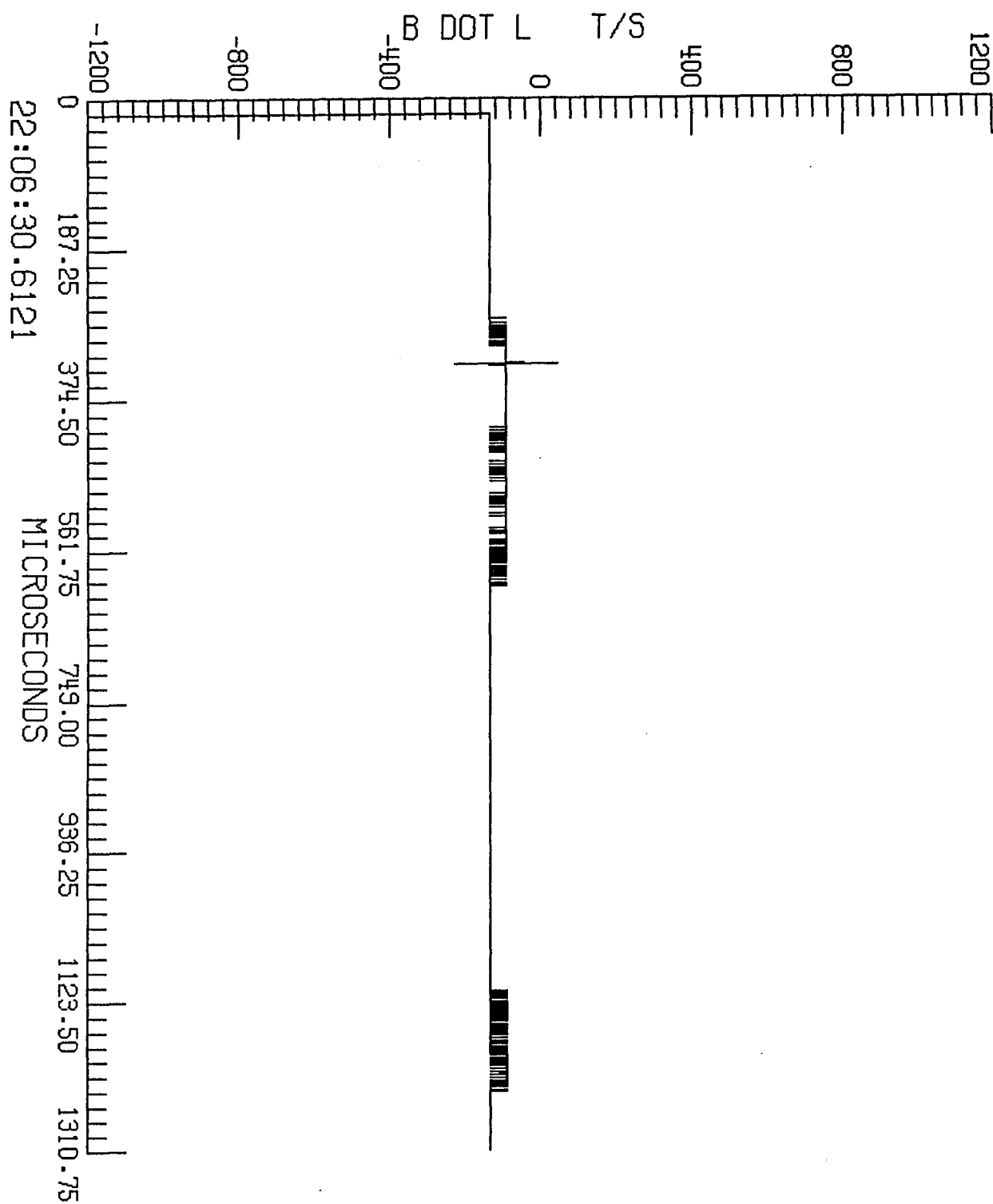
F106 LIGHTNING TK 8/THOMAS
RUN NO. 21 S-011

TEST NO. 83-0



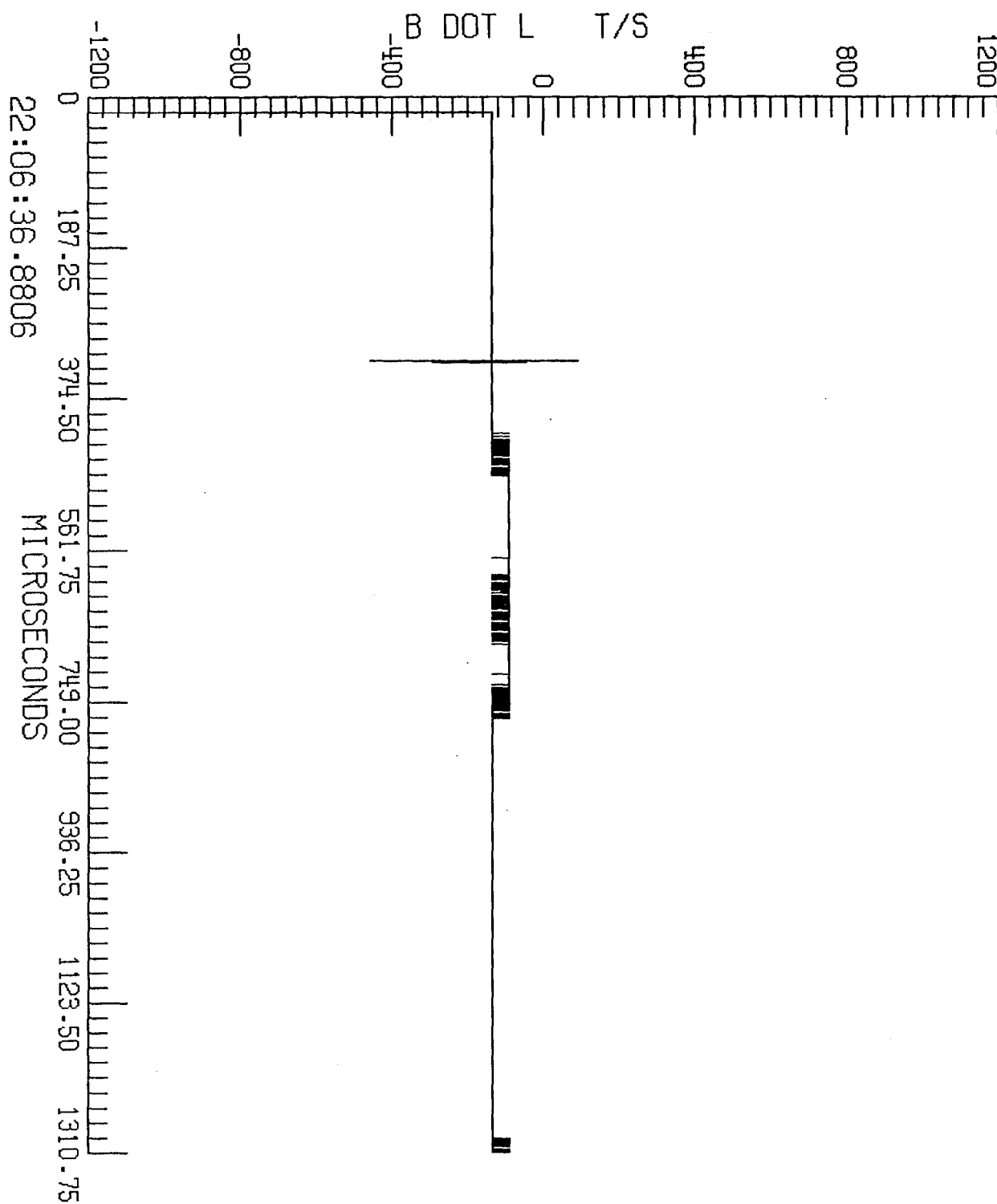
F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 21 S-011

TEST NO. 83.



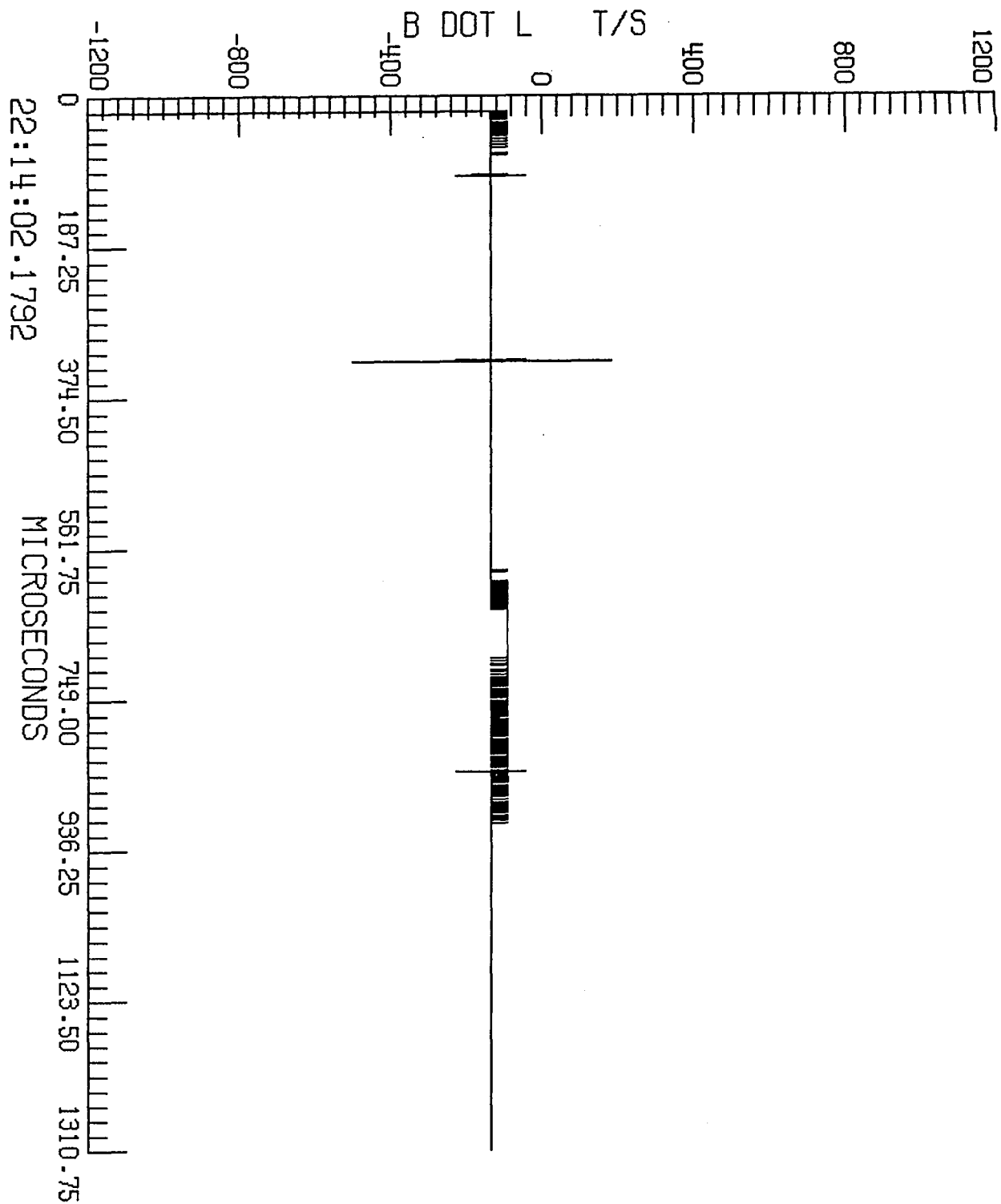
F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 22 N-012

TEST NO. 83



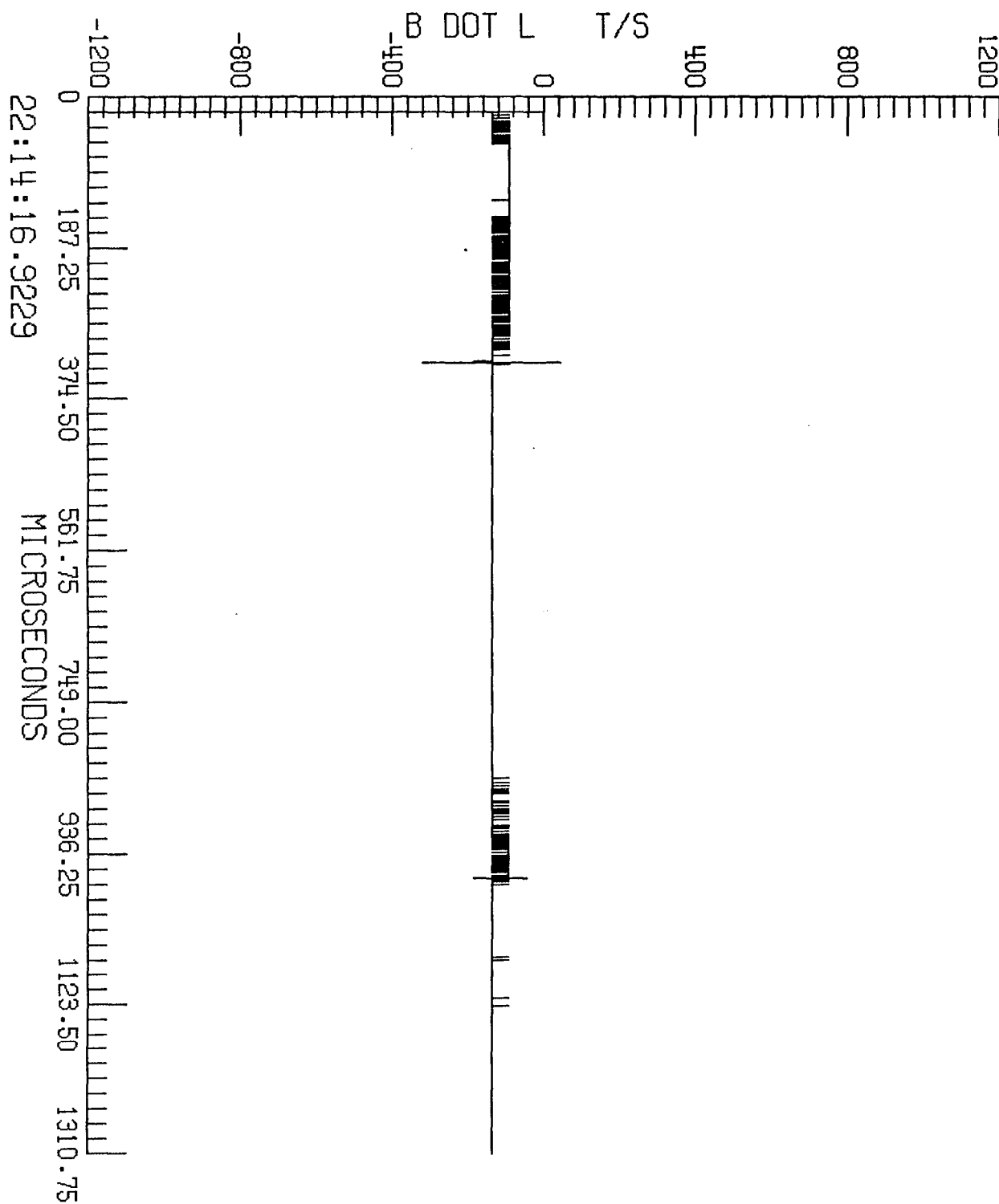
F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 23 N-013

TEST NO. 83-



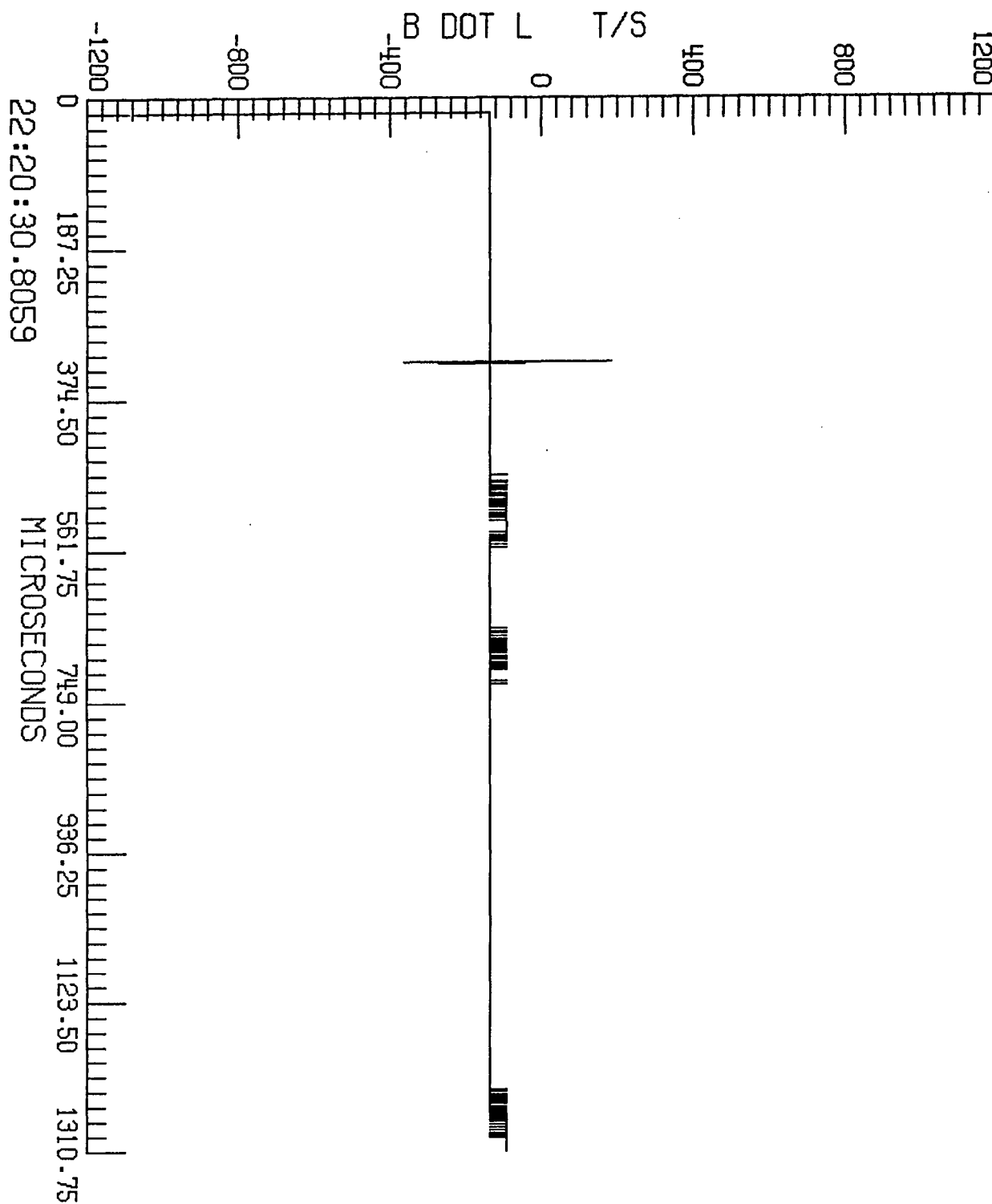
F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 24 S-012

TEST NO. 83-



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 25 N-014

TEST NO. 83

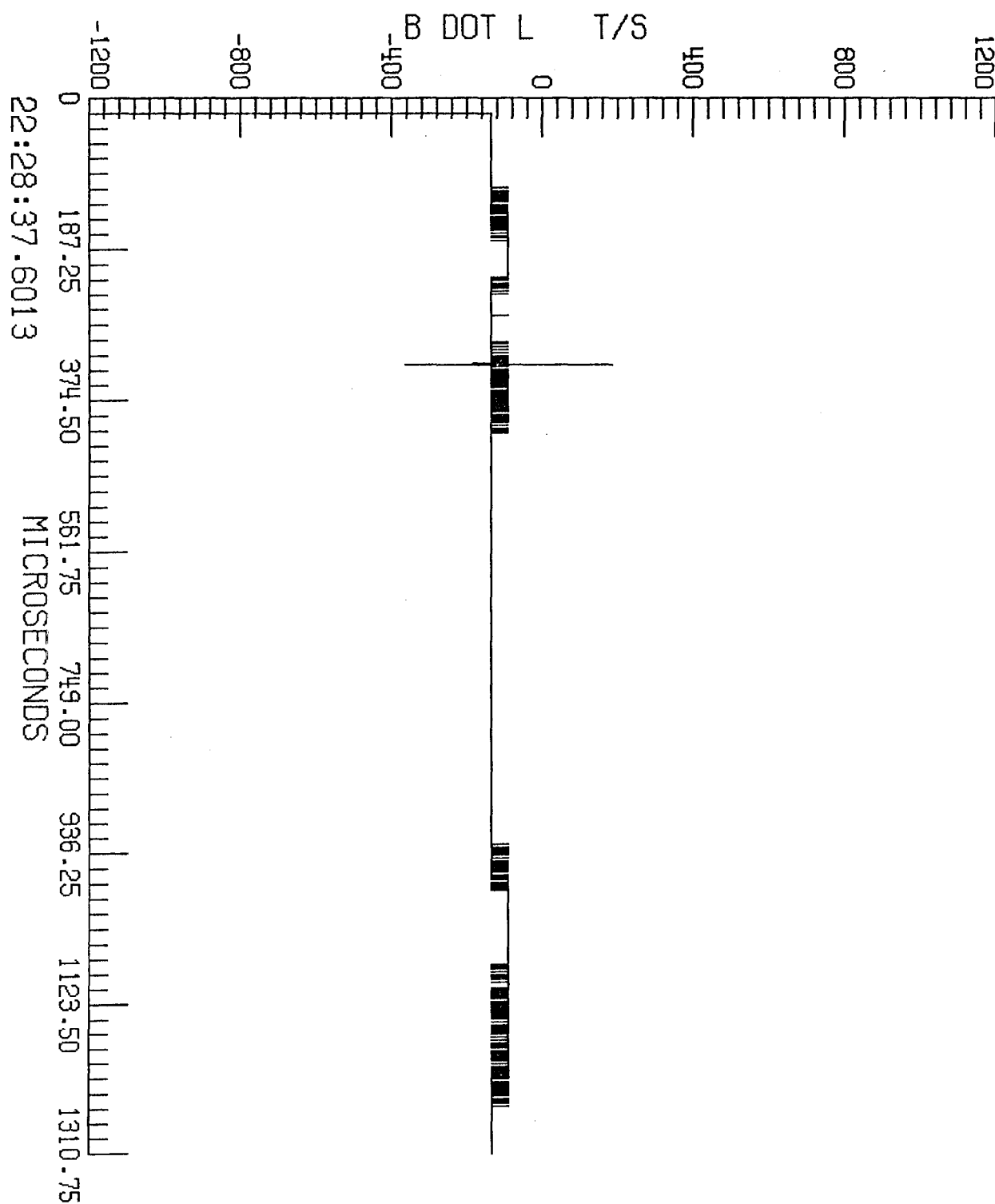


F106 LIGHTNING/TK.10/M.THOMAS

TEST NO. 83

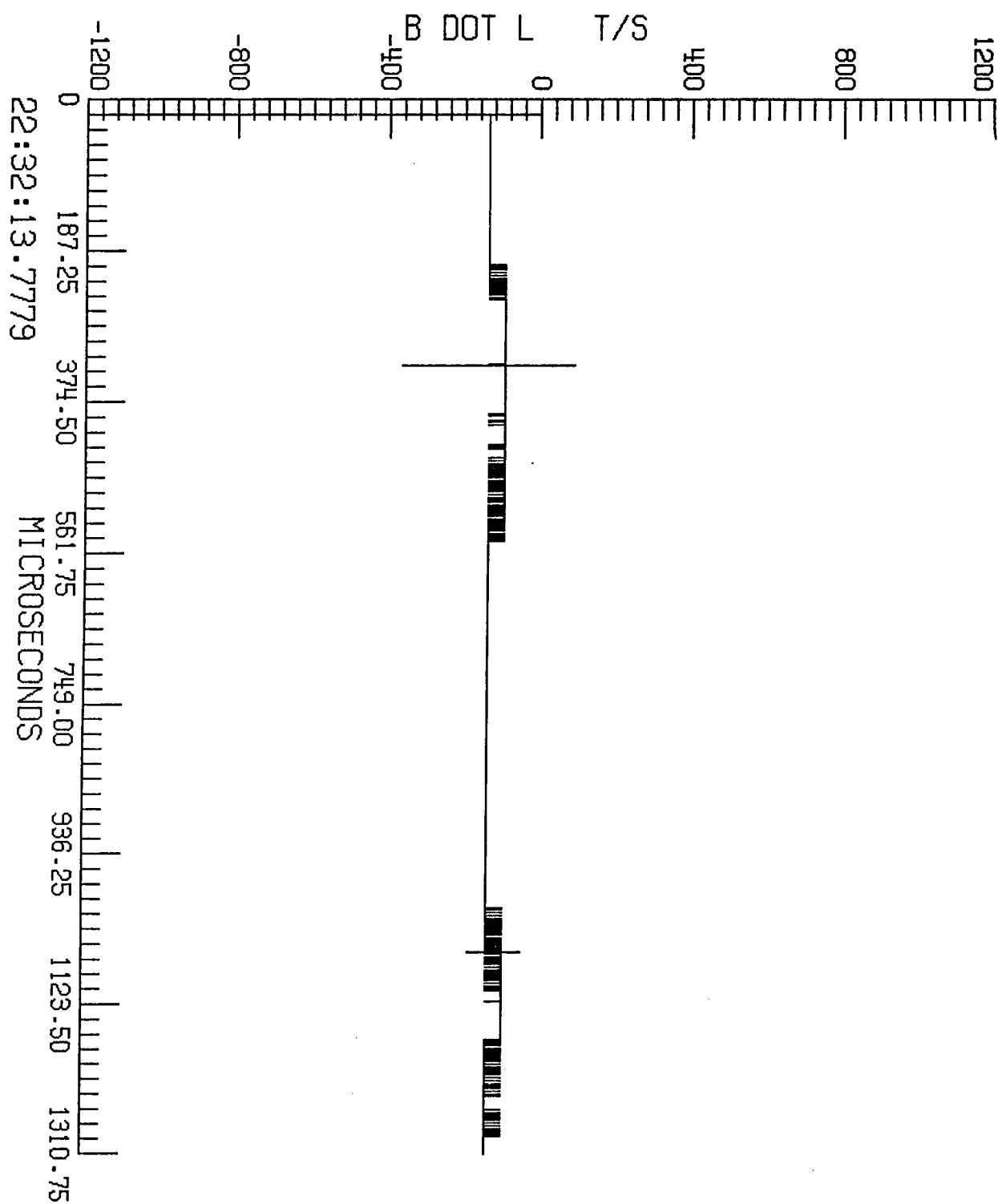
RUN NO. 26

N-015



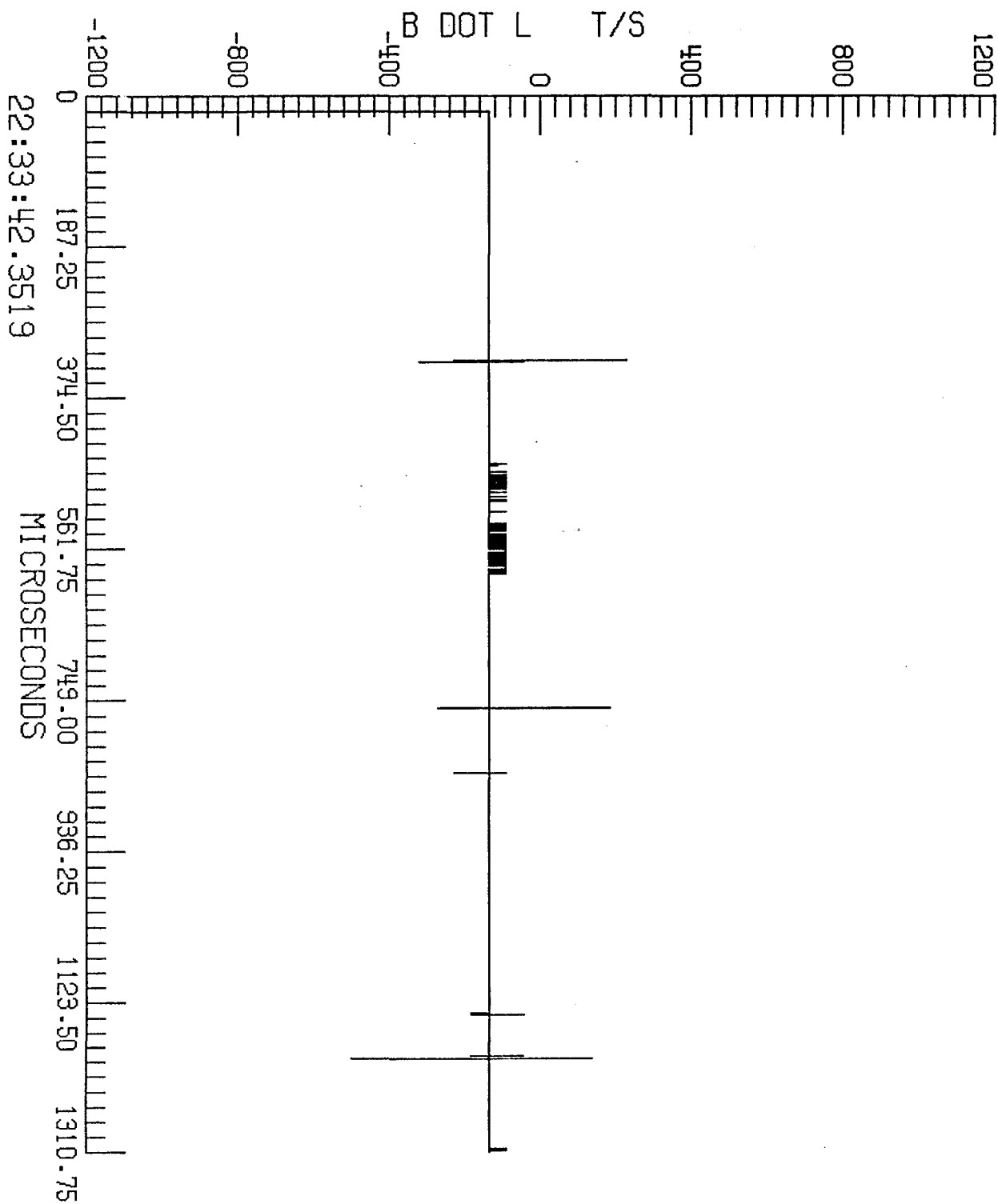
F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 27 S-015

TEST NO. 83



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 28 S-016

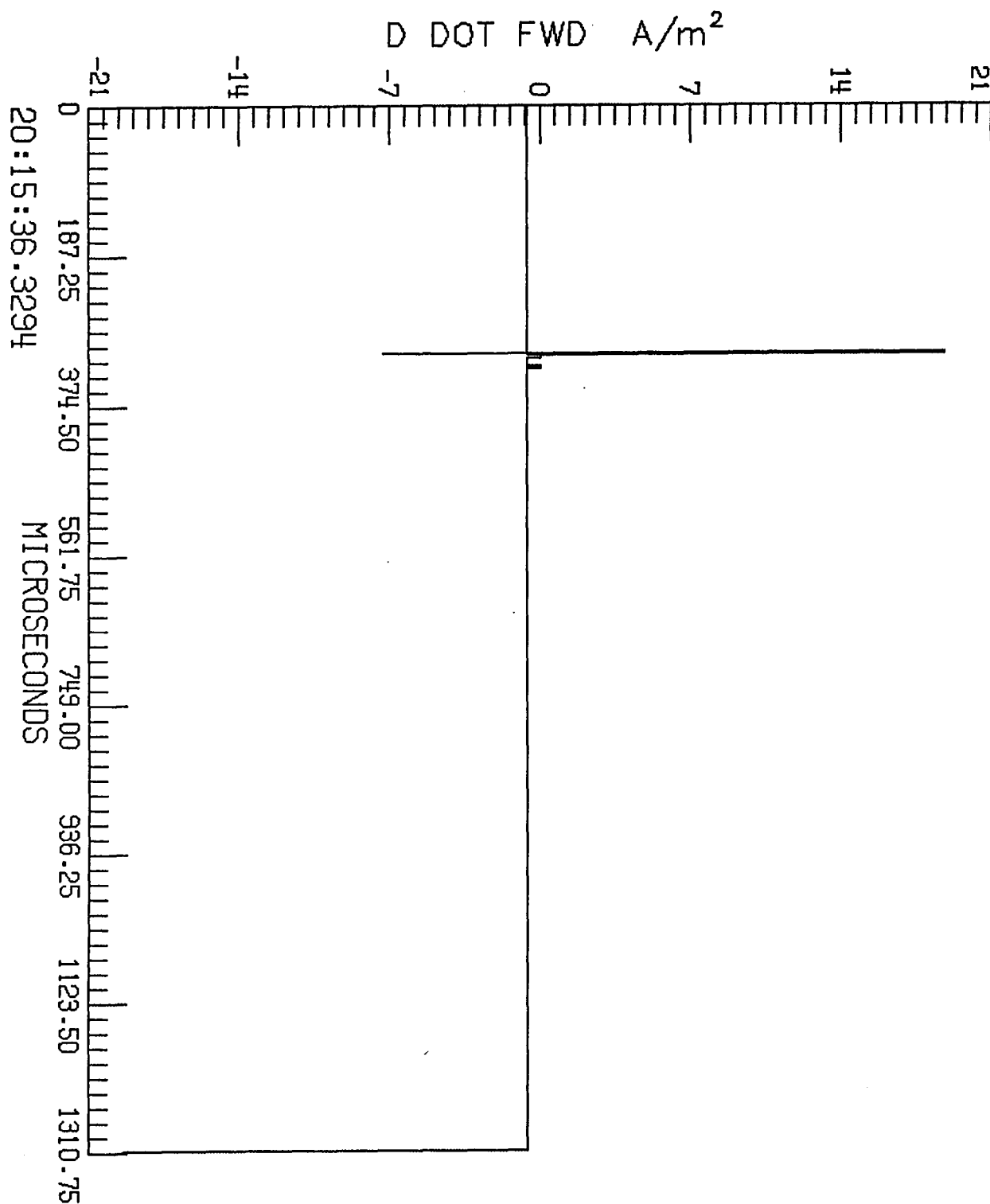
TEST NO. 83



F106 LIGHTNING TK 8/THOMAS
RUN NO. 1

S-002

TEST NO. 83-C

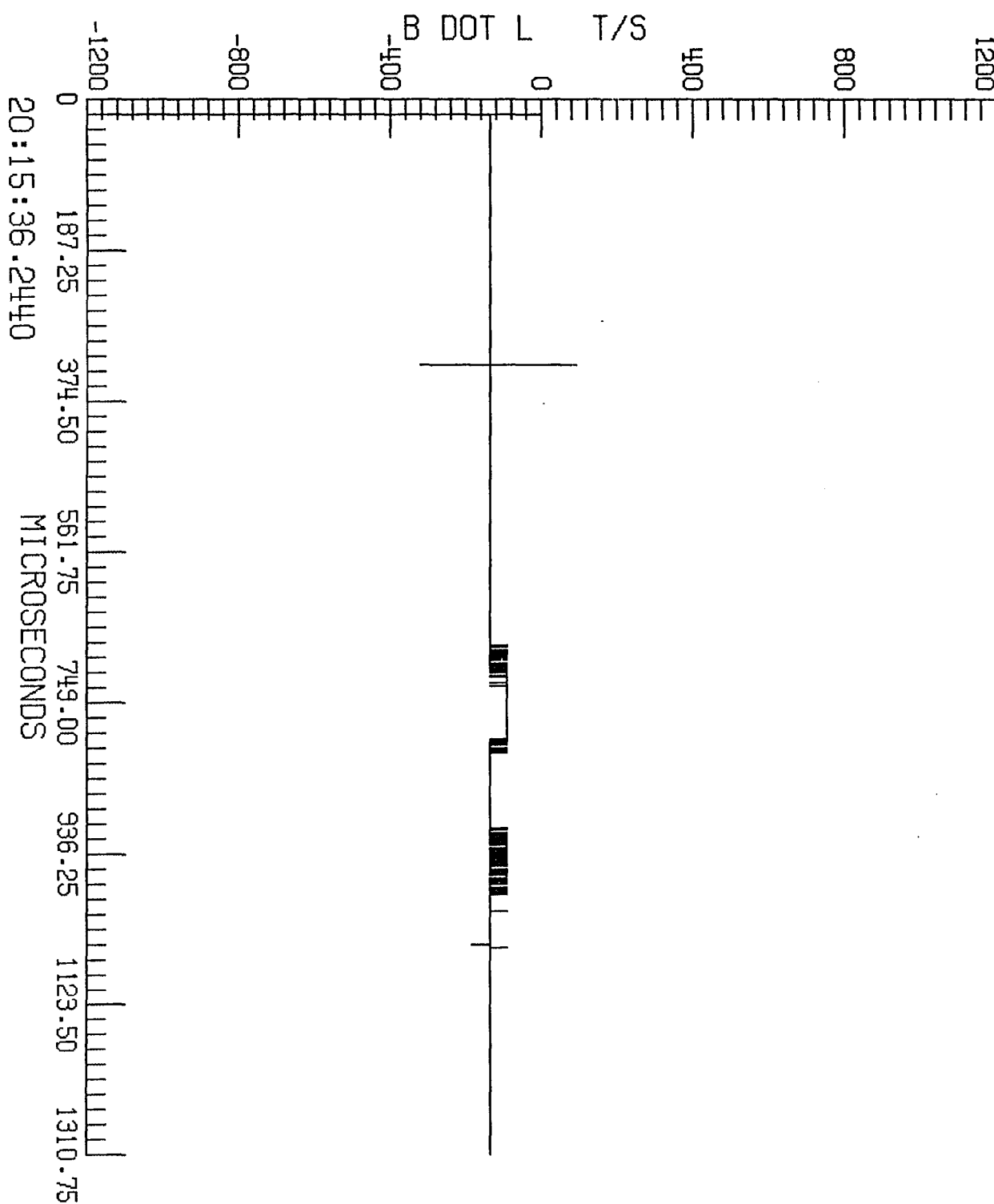


F106 LIGHTNING/TK.10/M.THOMAS

TEST NO. 83-

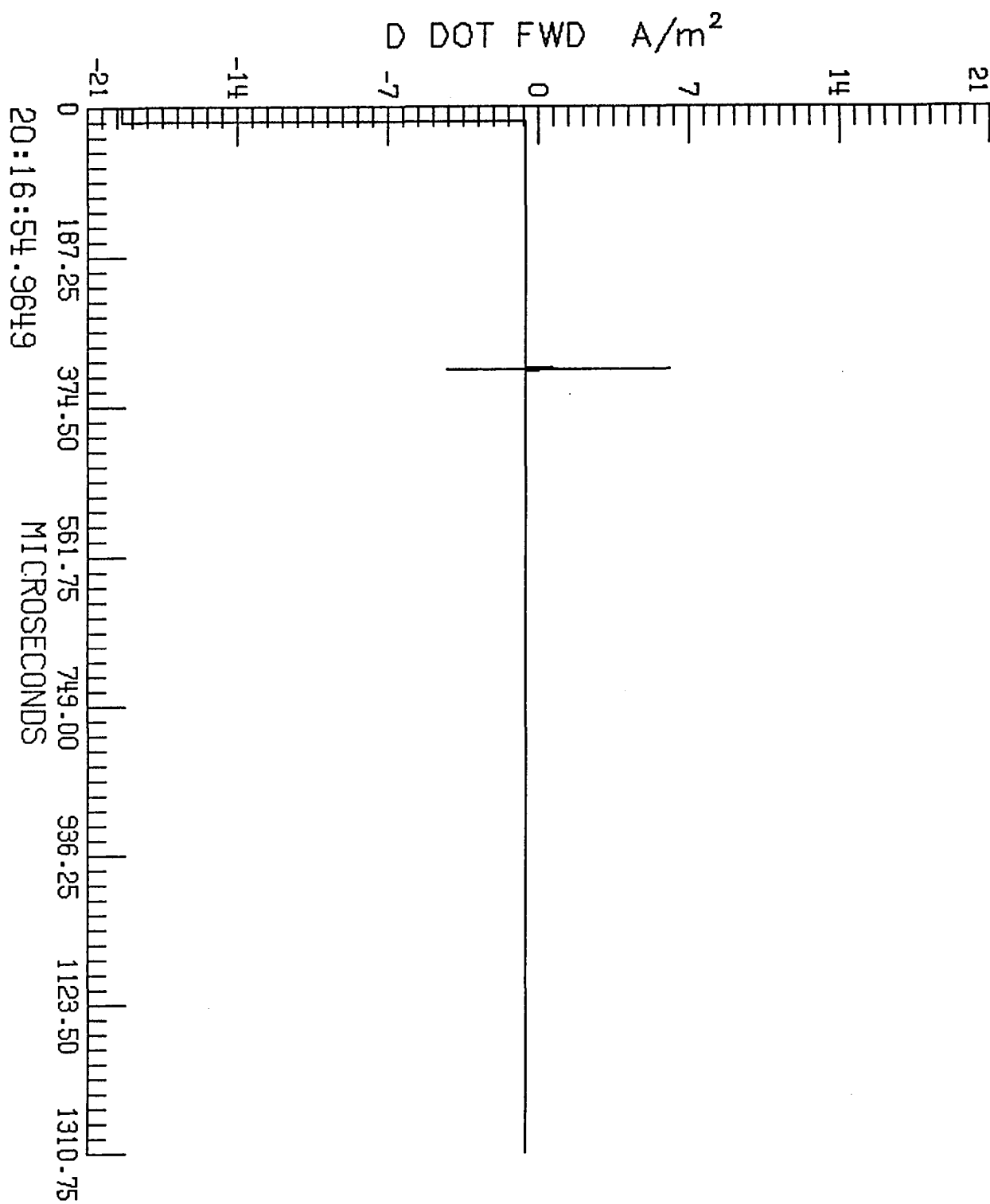
RUN NO. 1

S-002



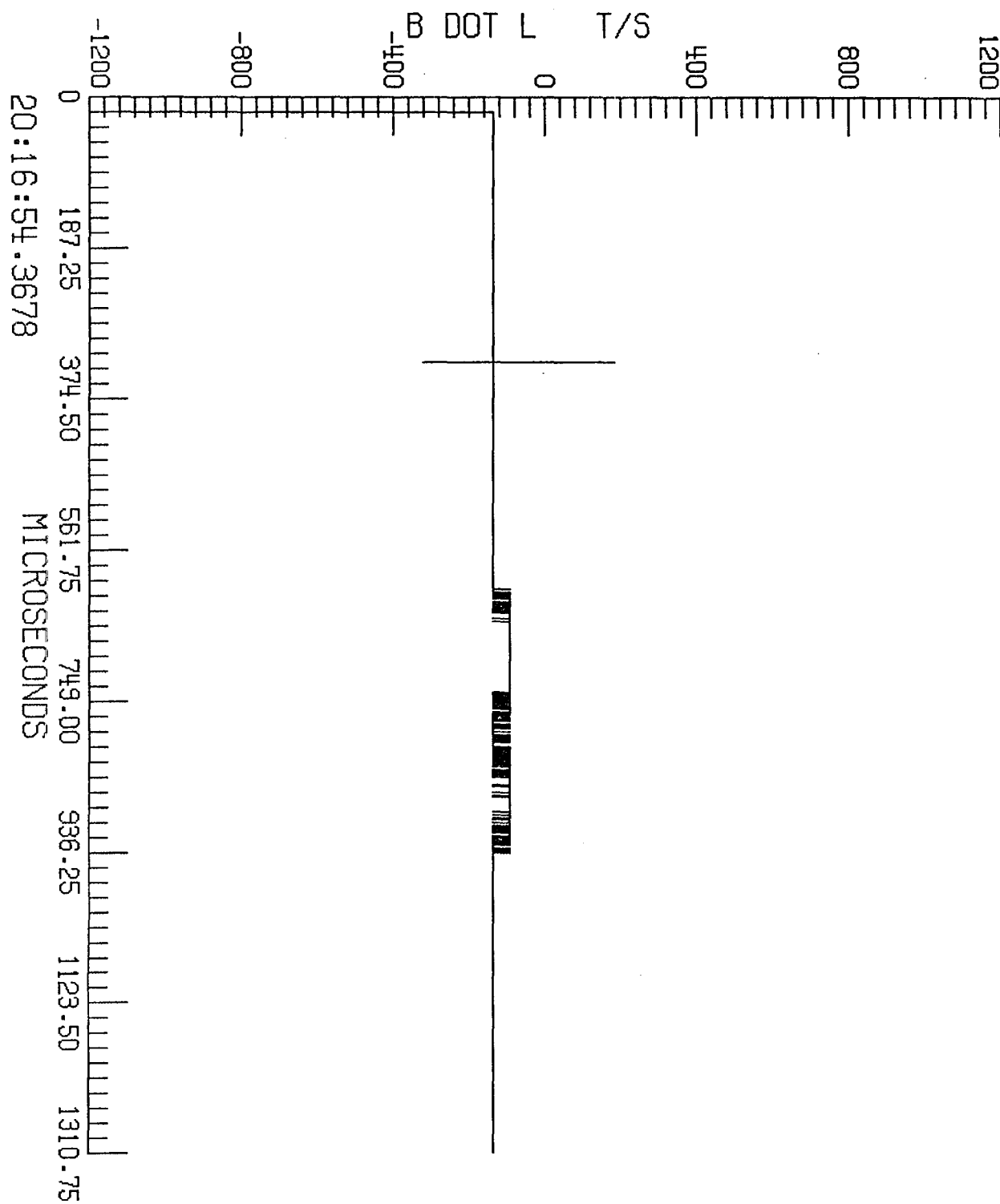
F106 LIGHTNING TK 8/THOMAS
RUN NO. 2 N-001

TEST NO. 83-C



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 2 N-001

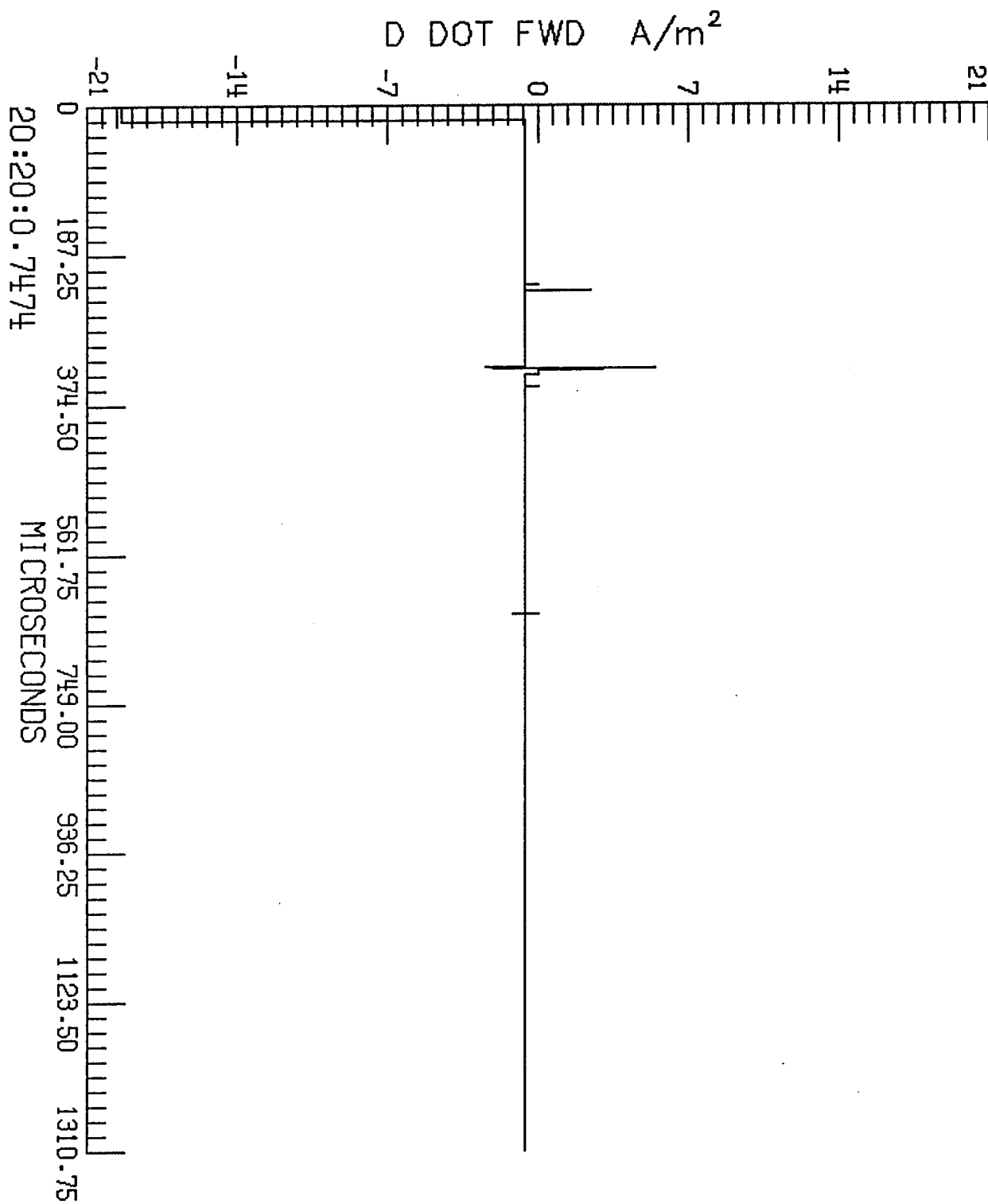
TEST NO. 83



F106 LIGHTNING TK 8/THOMAS
RUN NO. 3

S-003

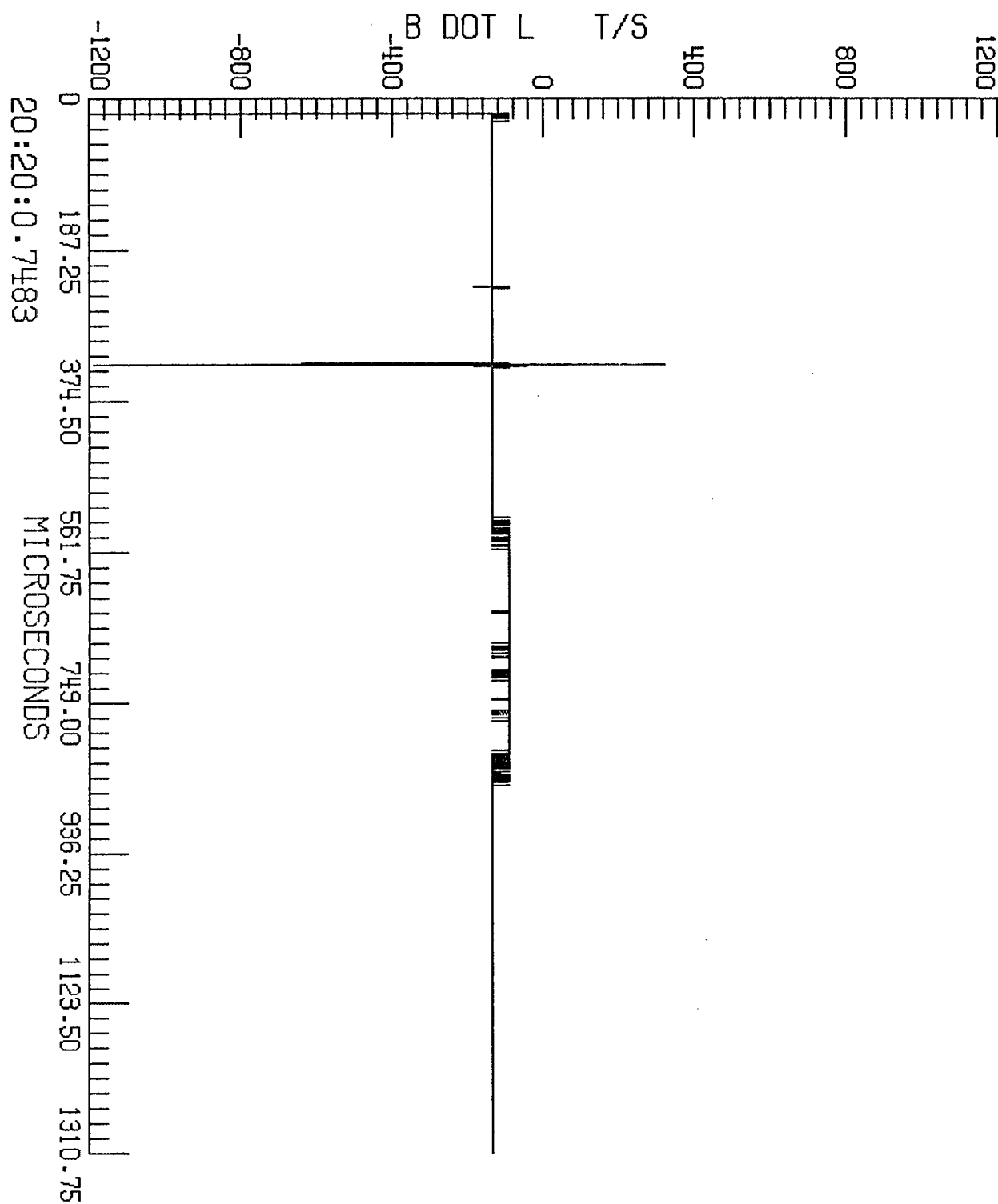
TEST NO. 83-0



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 3

S-003

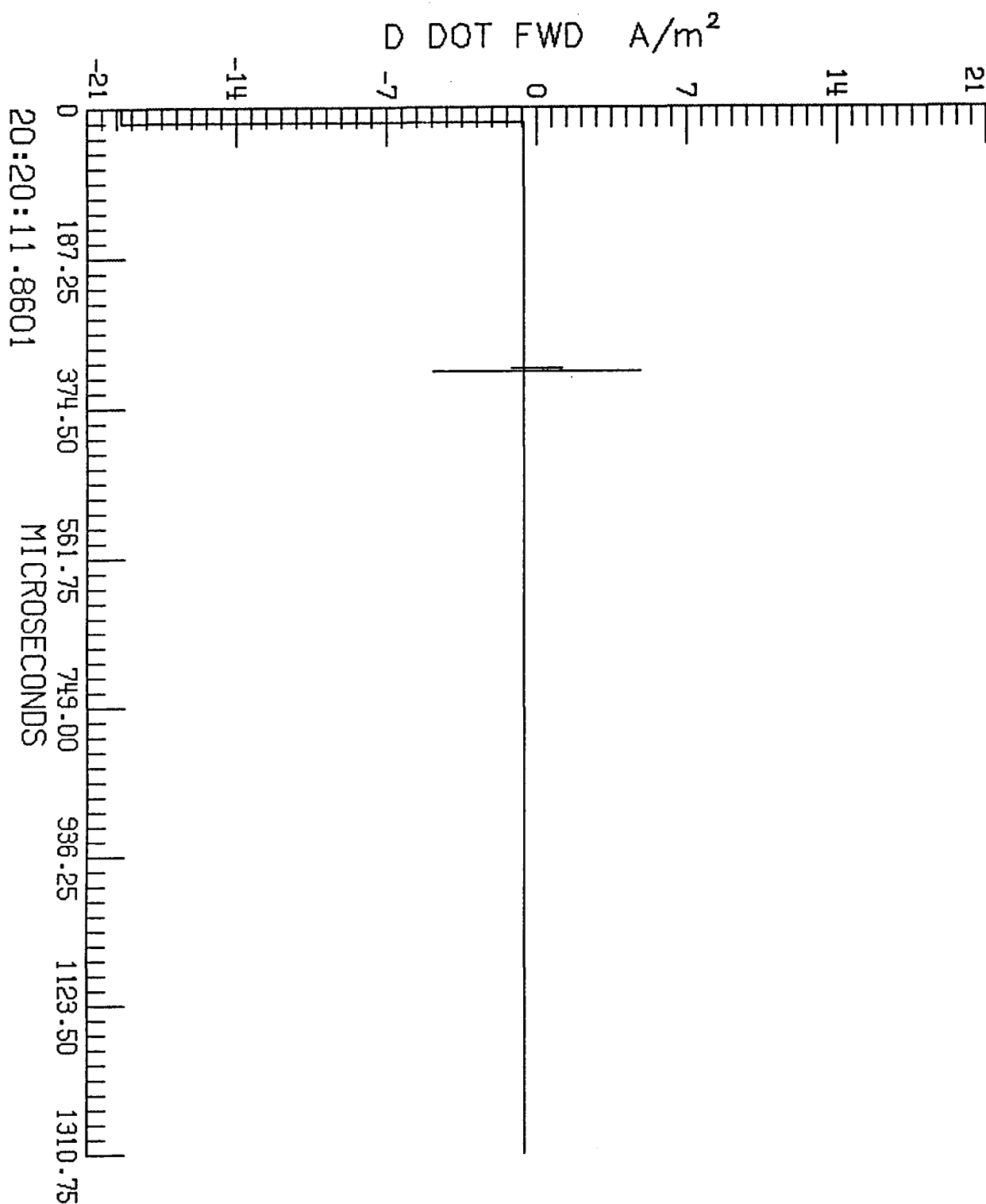
TEST NO. 83.



F106 LIGHTNING TK 8/THOMAS
RUN NO. 4

S-005

TEST NO. 83-C

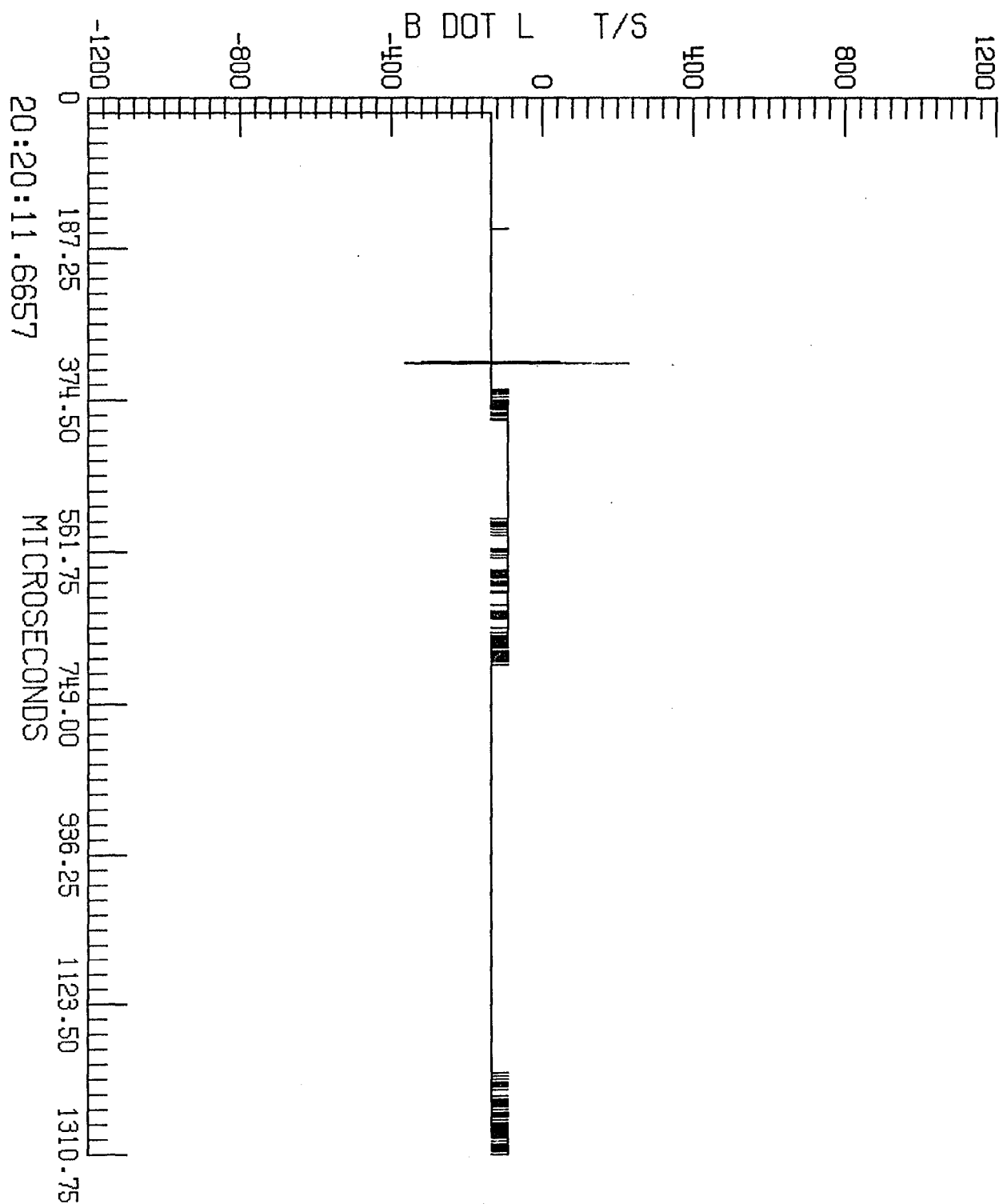


F106 LIGHTNING/TK.10/M.THOMAS

TEST NO. 83-

RUN NO. 4

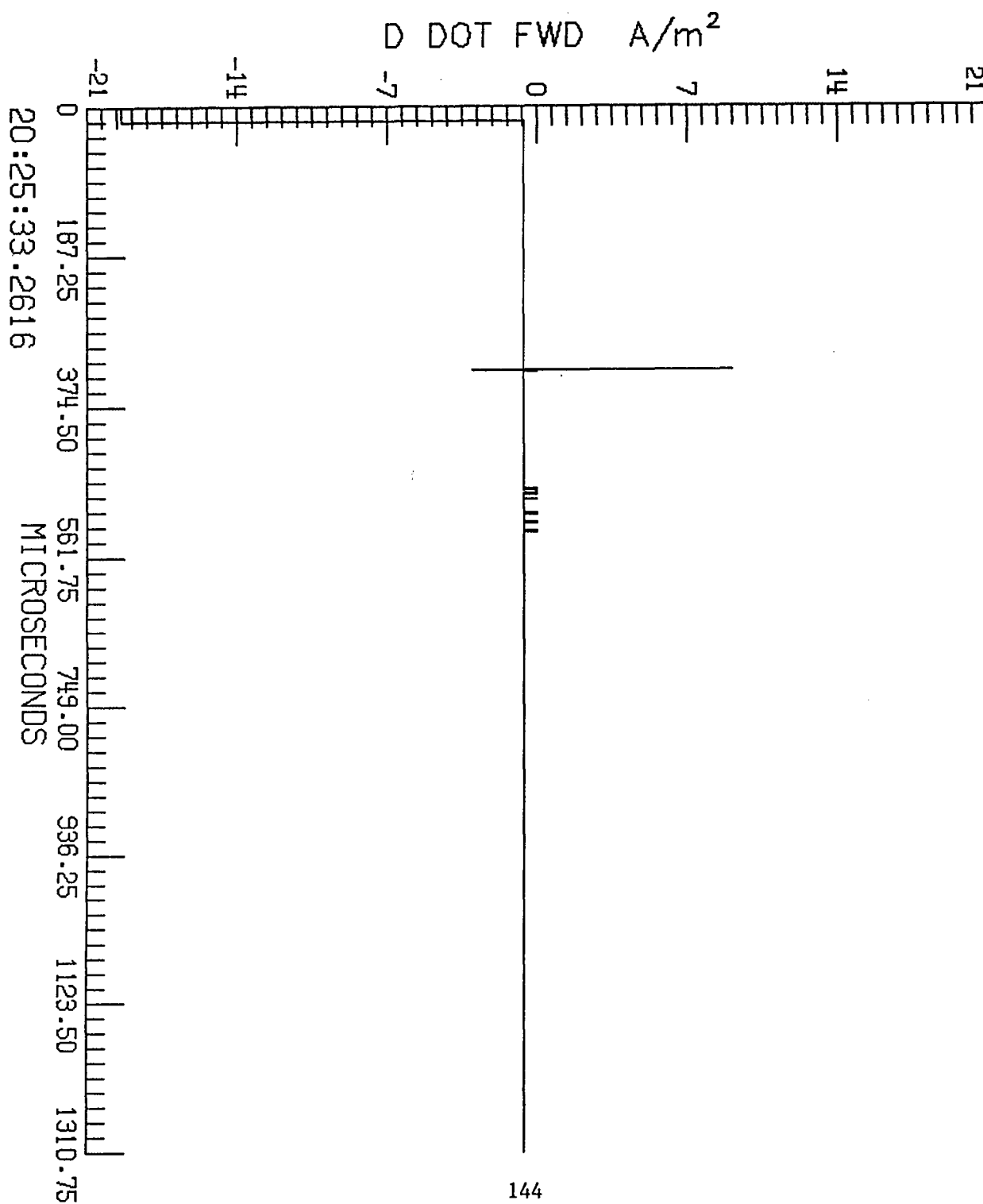
S-005



F106 LIGHTNING TK 8/THOMAS
RUN NO. 5

S-006

TEST NO. 83-C

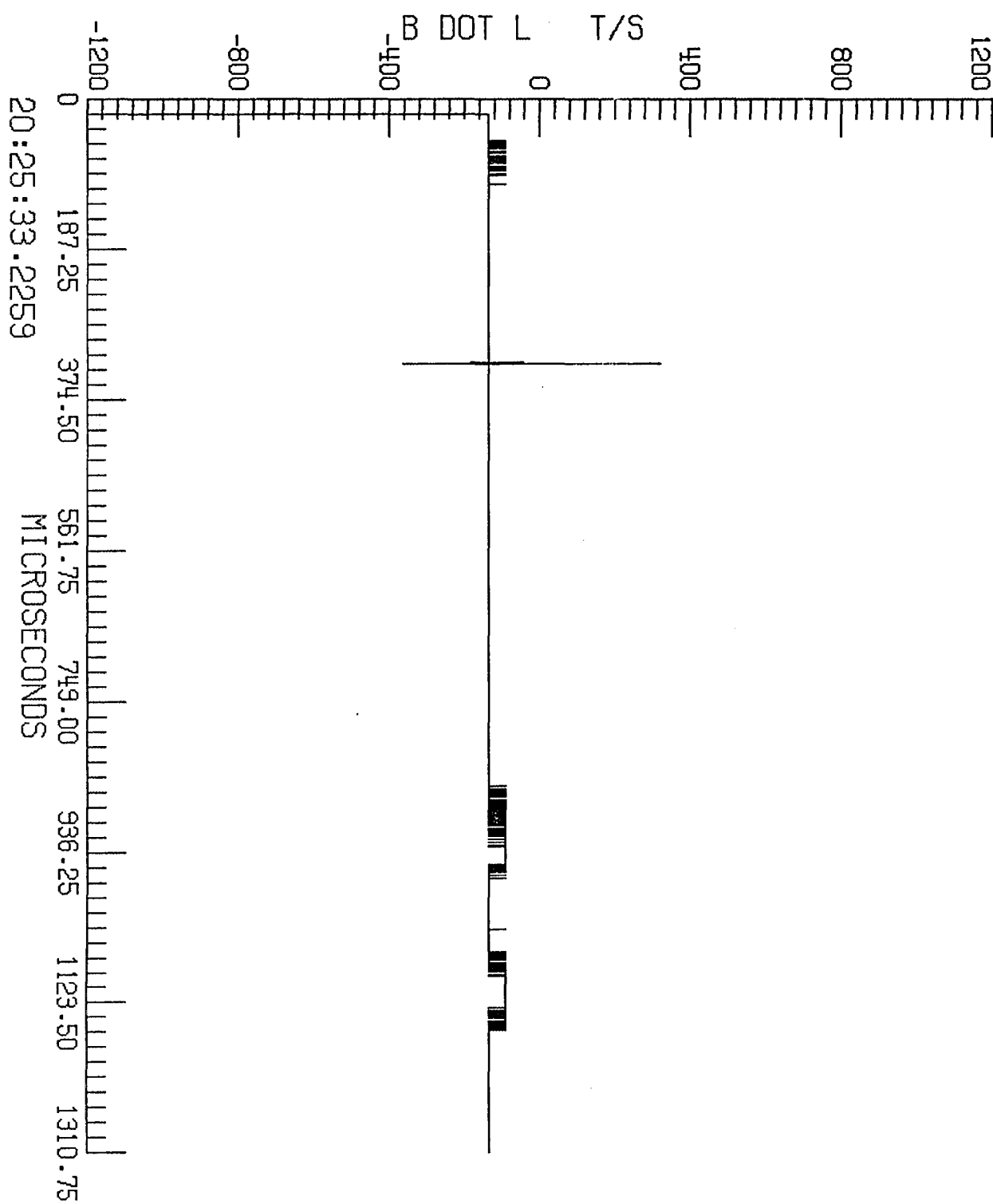


F106 LIGHTNING/TK.10/M.THOMAS

TEST NO. 83

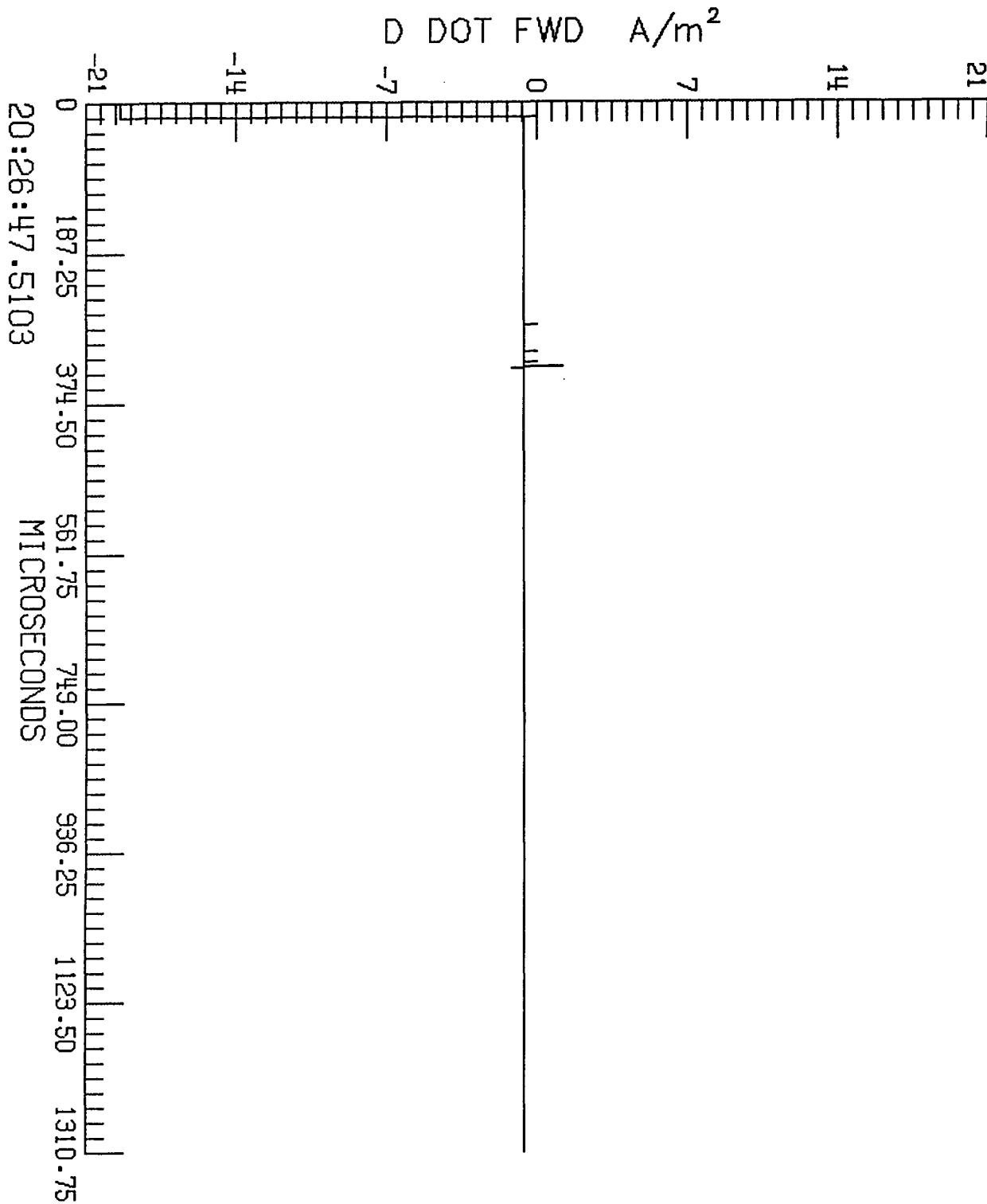
RUN NO. 5

S-006



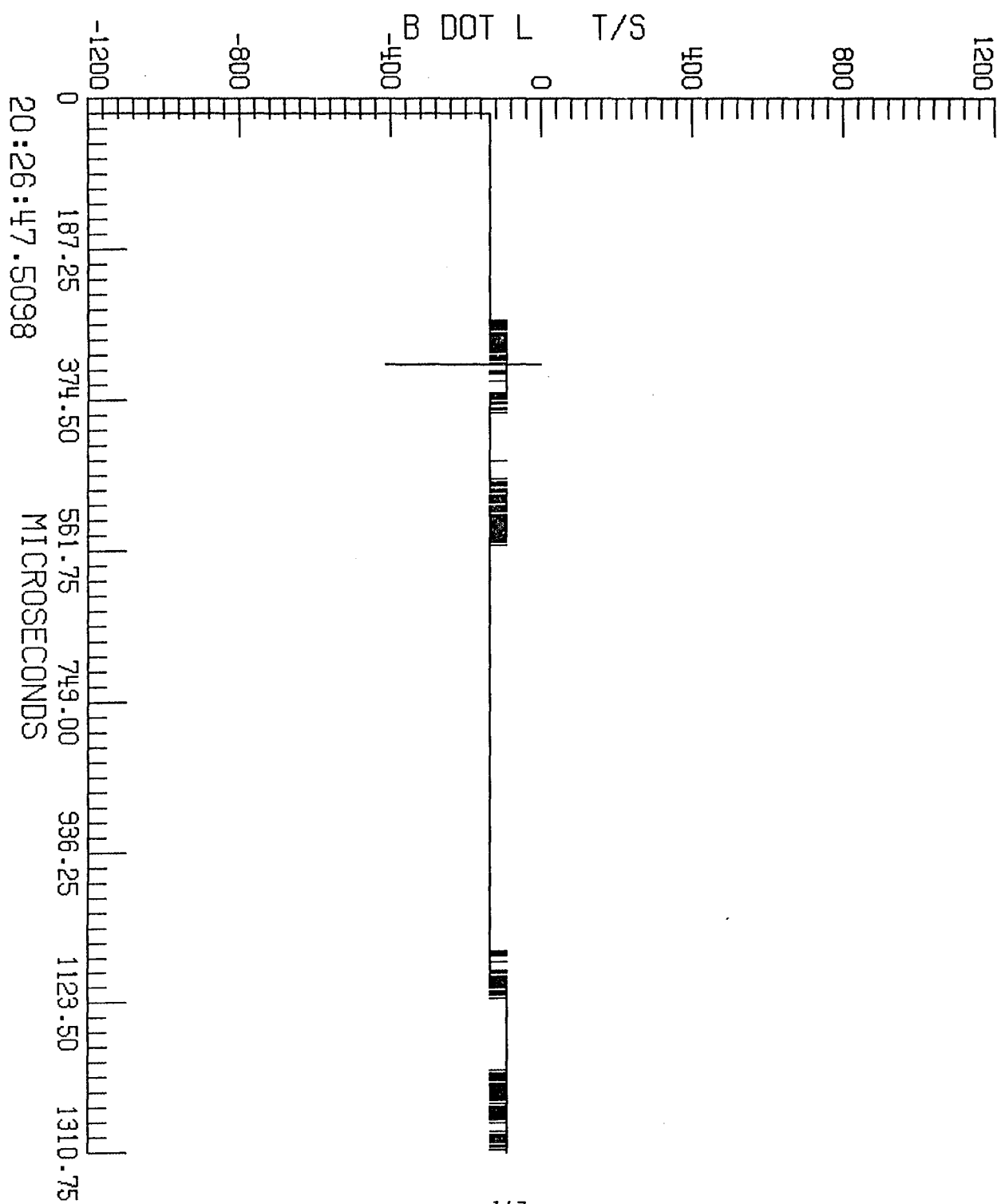
F106 LIGHTNING TK 8/THOMAS
RUN NO. 6

TEST NO. 83-0



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 6

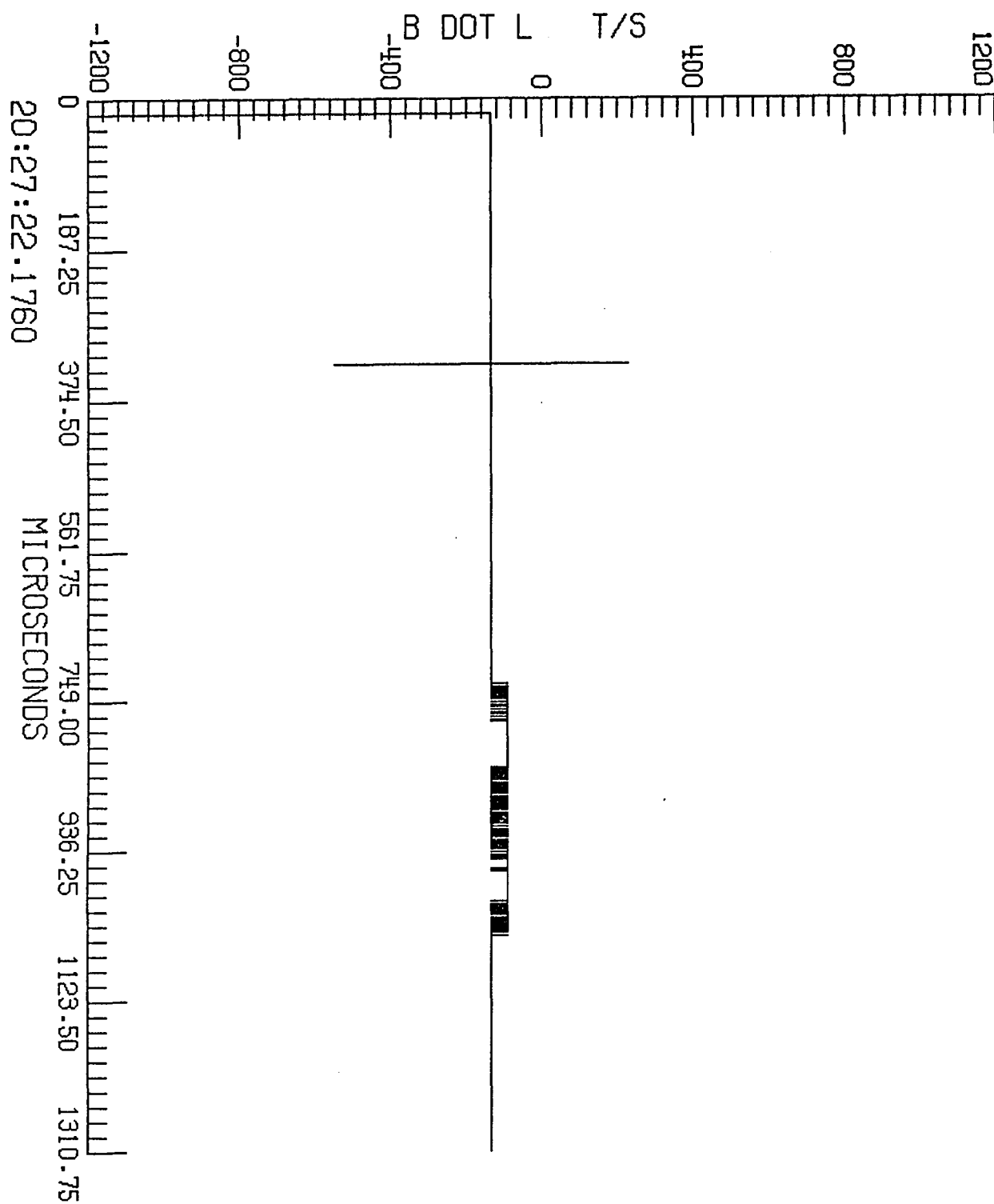
TEST NO. 83



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 7

TEST NO. 83-

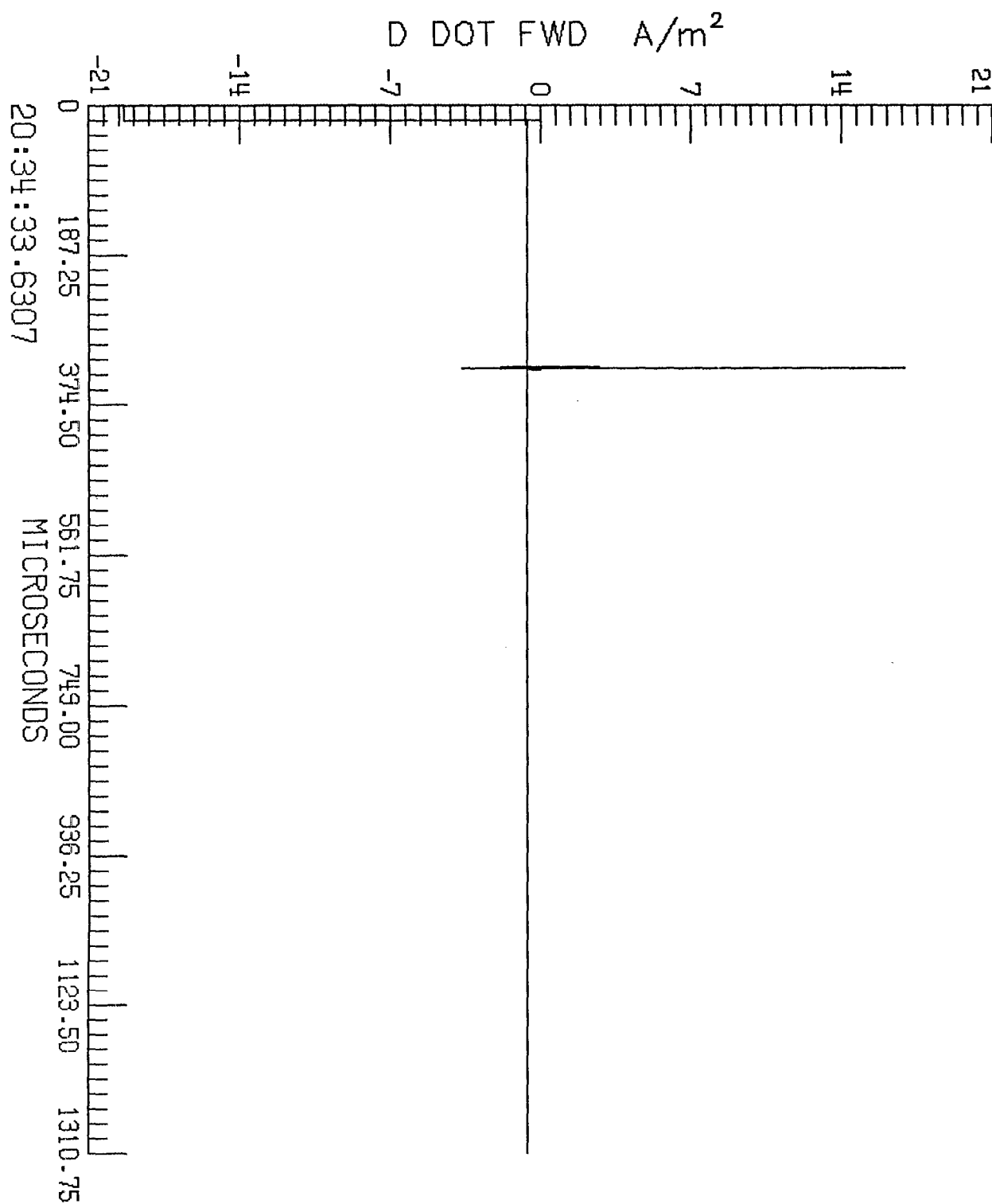
N-003



F106 LIGHTNING TK 8/THOMAS
RUN NO. 8

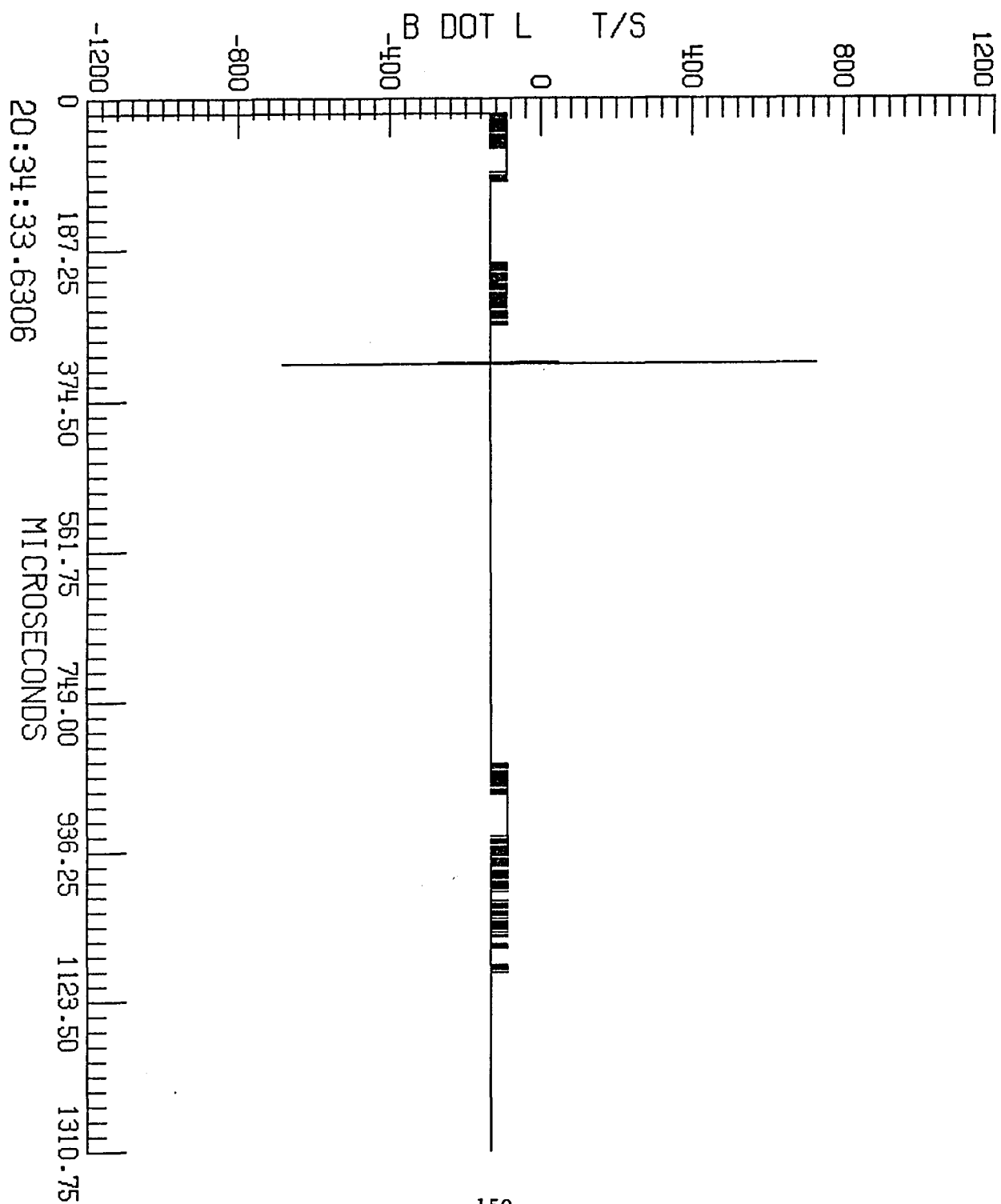
S-007

TEST NO. 83-0



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 8 S-007

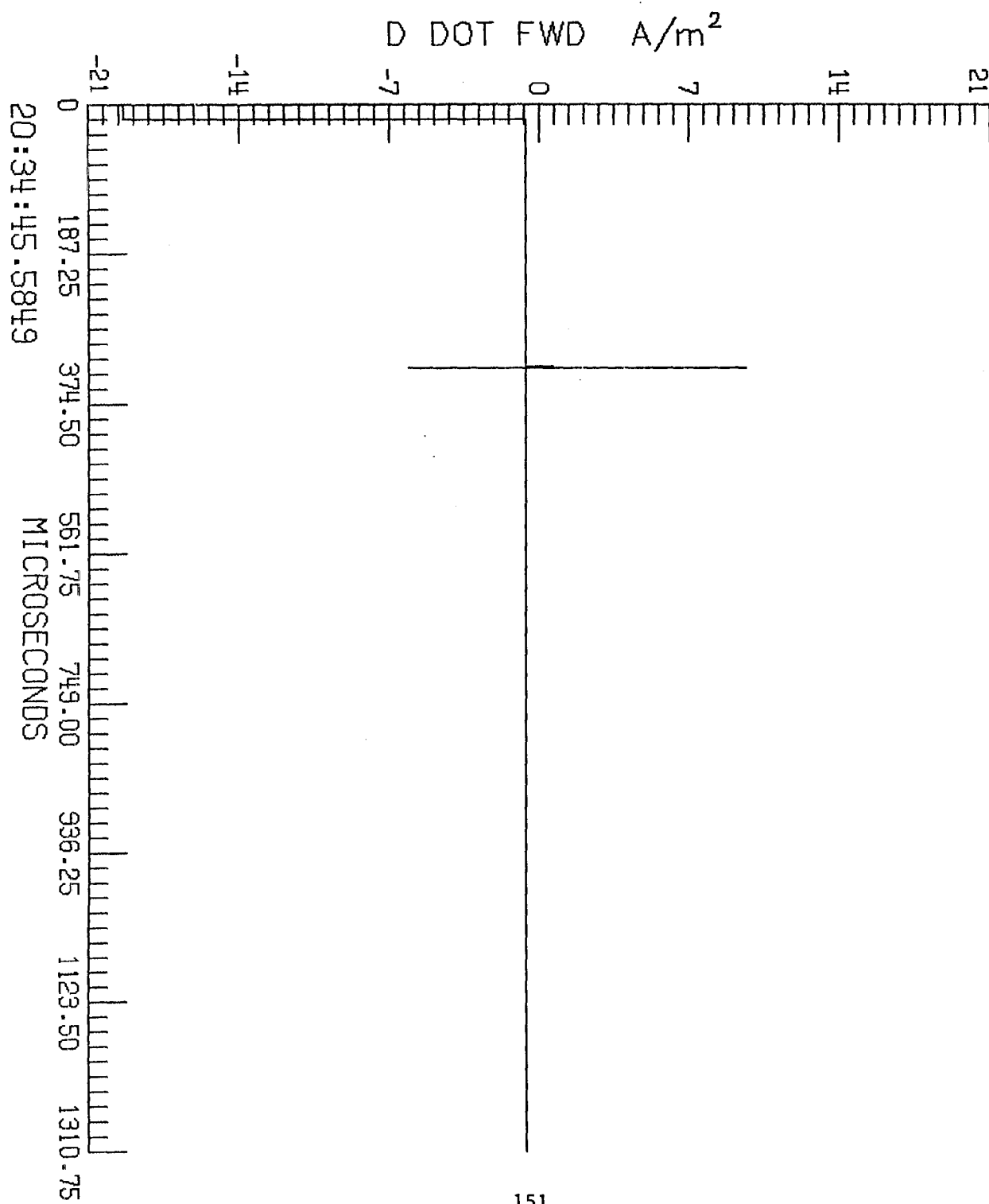
TEST NO. 83-



F106 LIGHTNING TK 8/THOMAS
RUN NO. 9

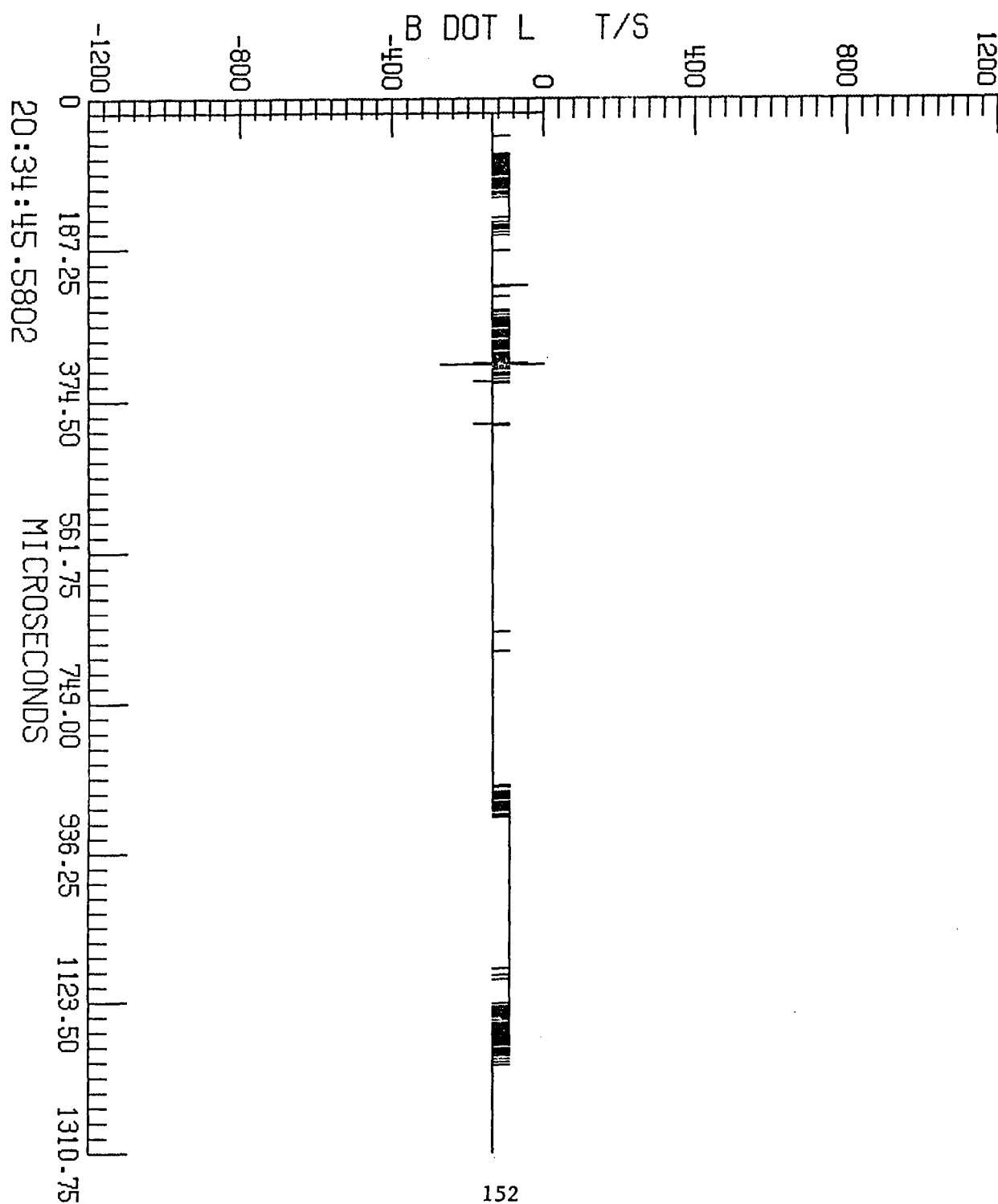
S-008

TEST NO. 83-



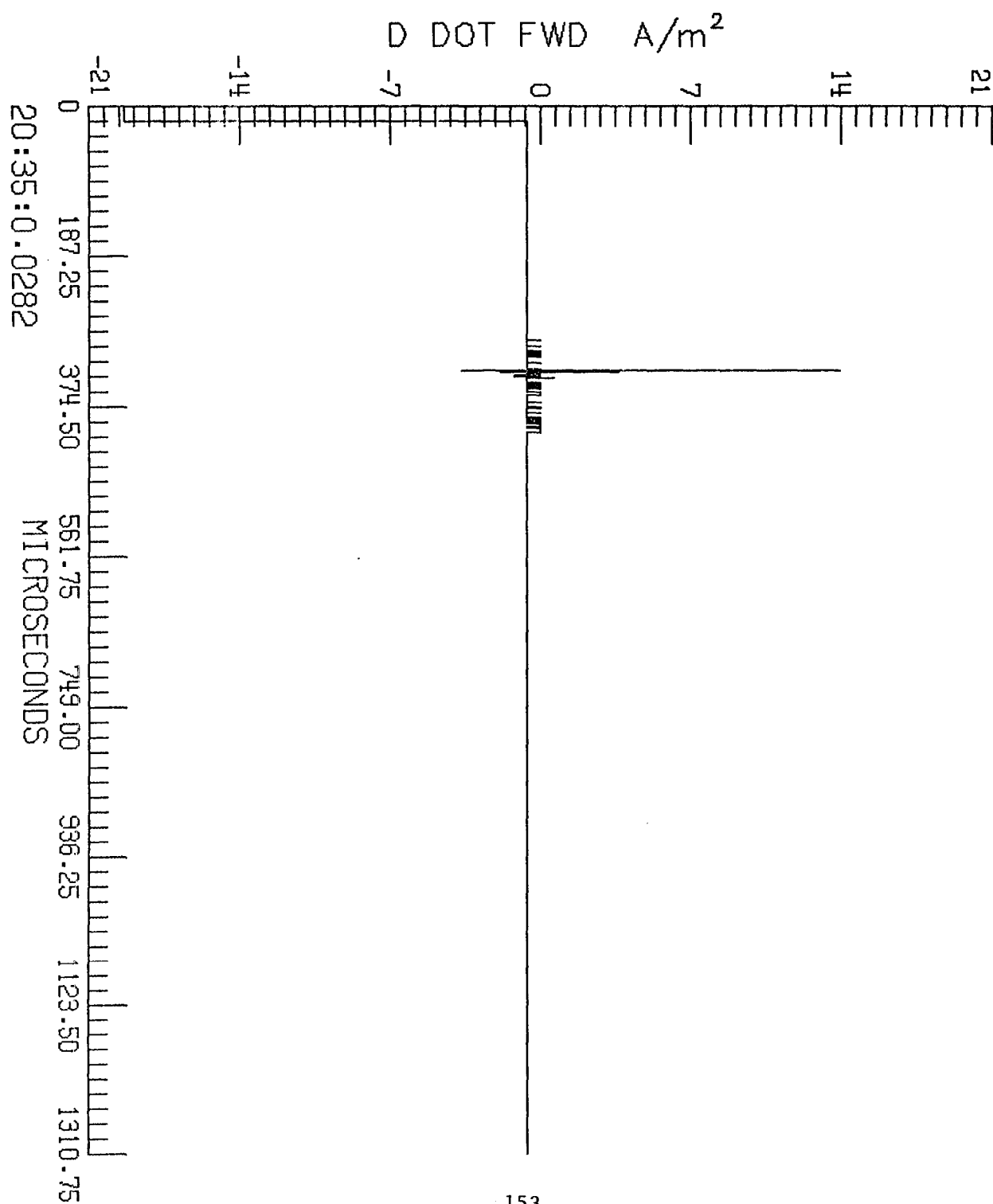
F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 9 S-008

TEST NO. 83-



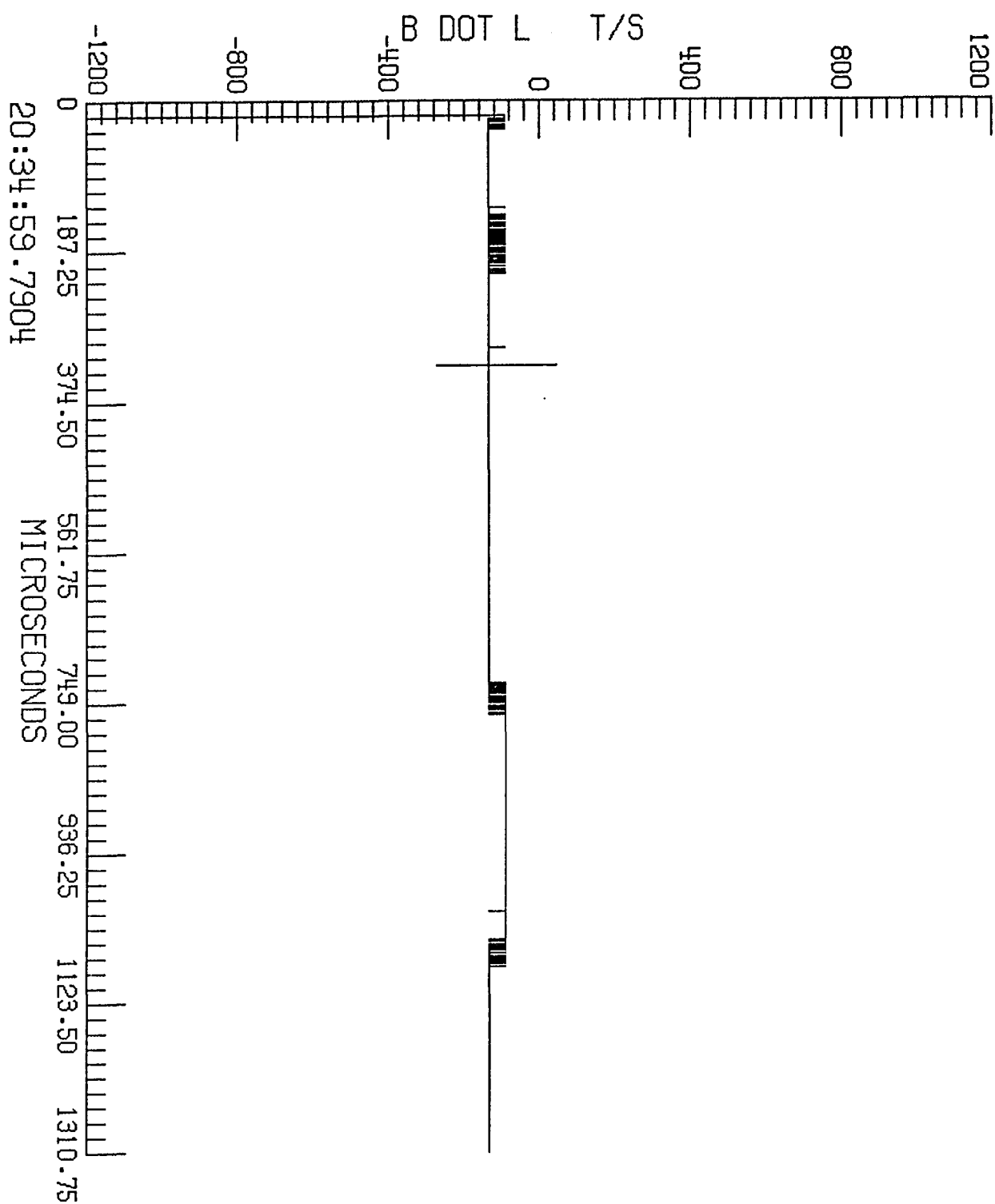
F106 LIGHTNING TK 8/THOMAS
RUN NO. 10 S-009

TEST NO. 83-



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 10 S-009

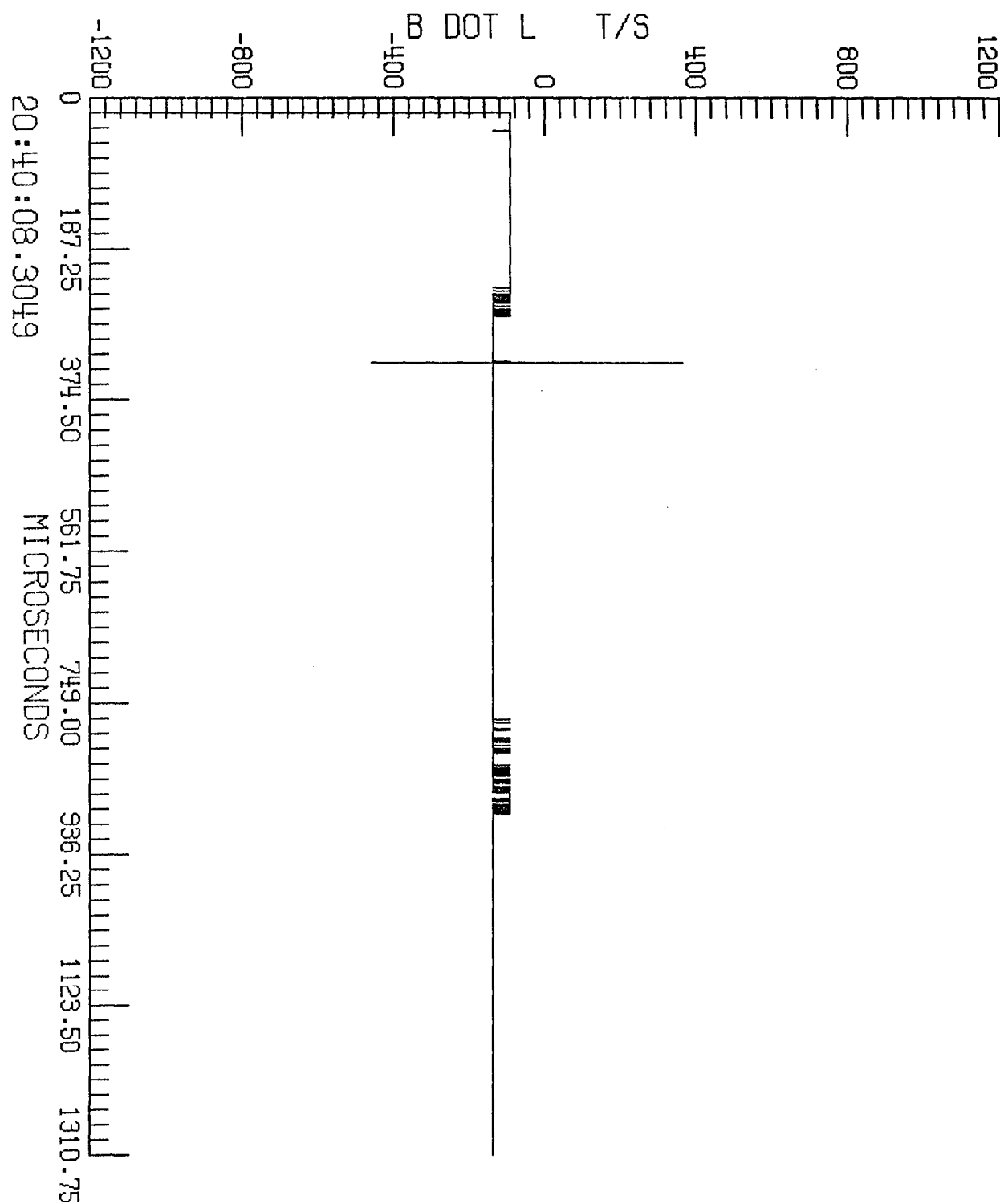
TEST NO. 83-



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 11

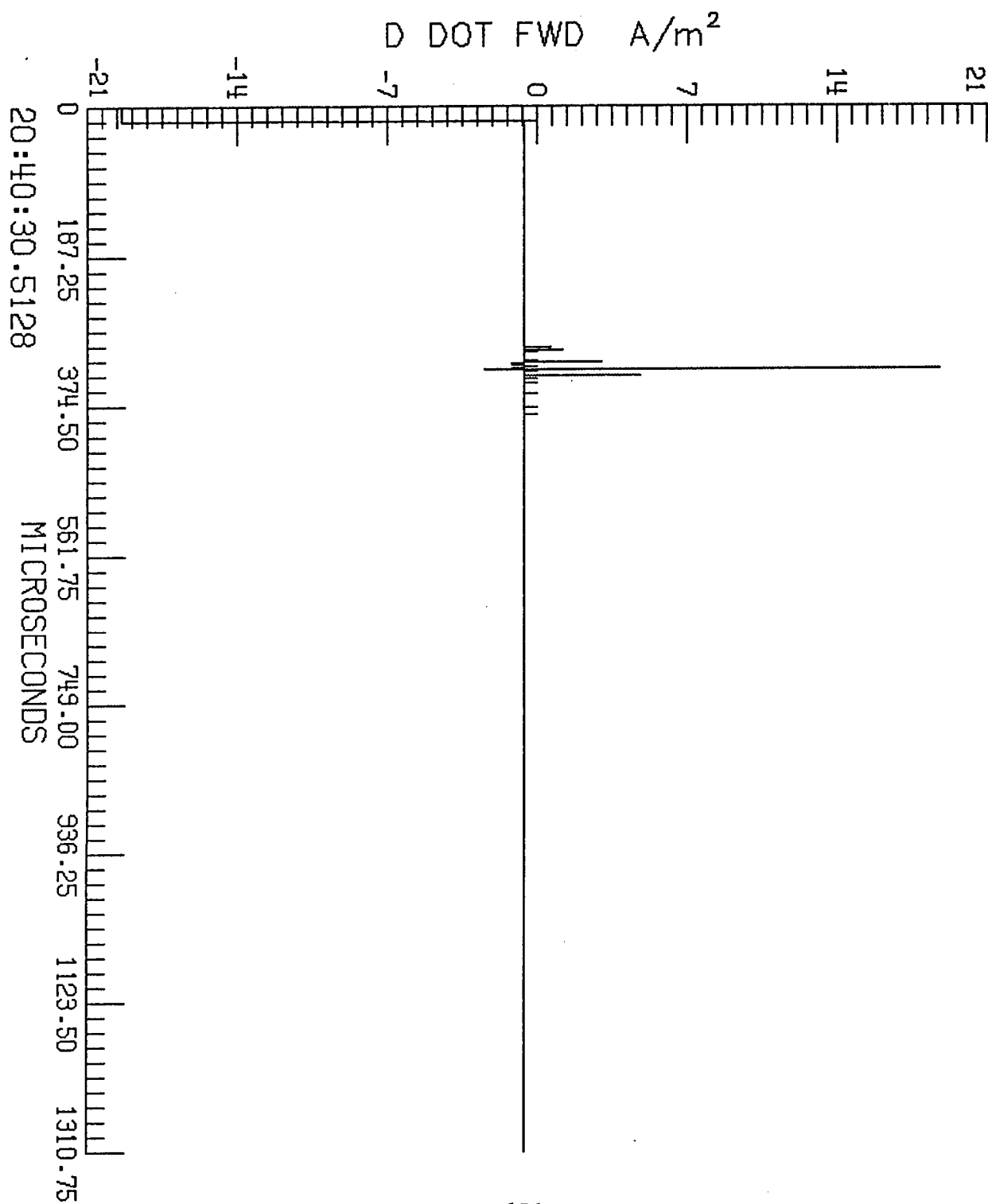
N-004

TEST NO. 83



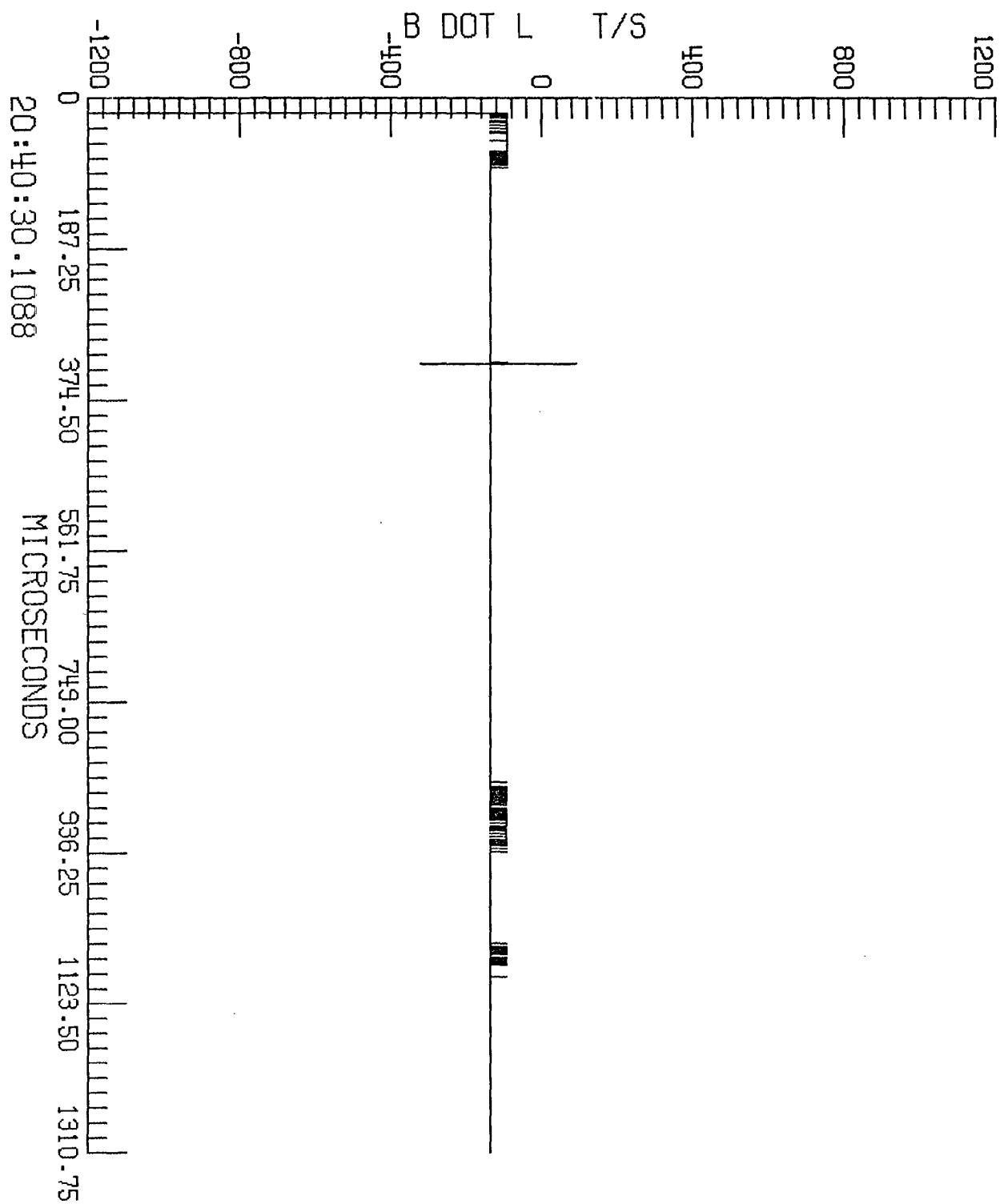
F106 LIGHTNING TK 8/THOMAS
RUN NO. 12 S-010

TEST NO. 83



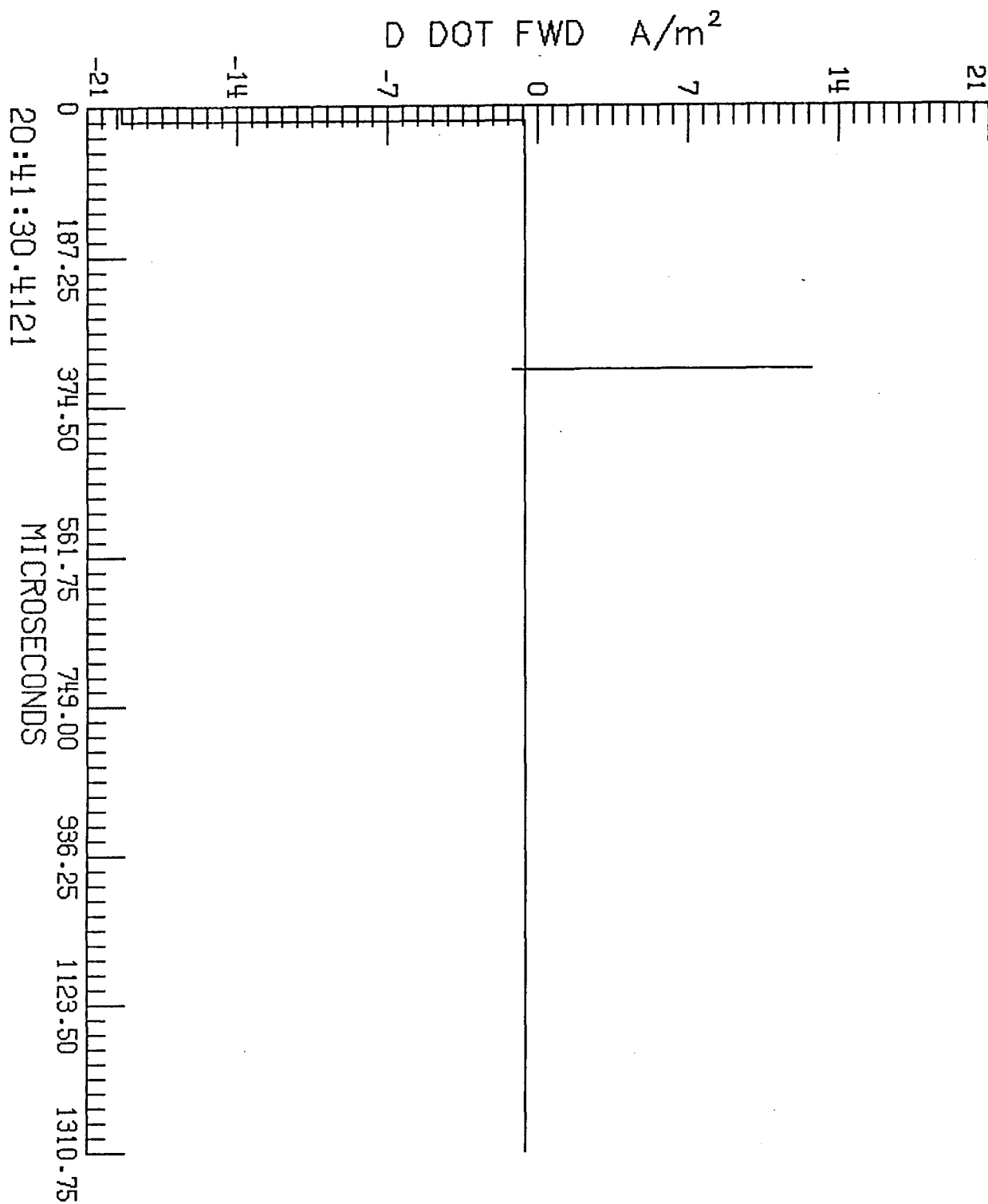
F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 12 S-010

TEST NO. 83



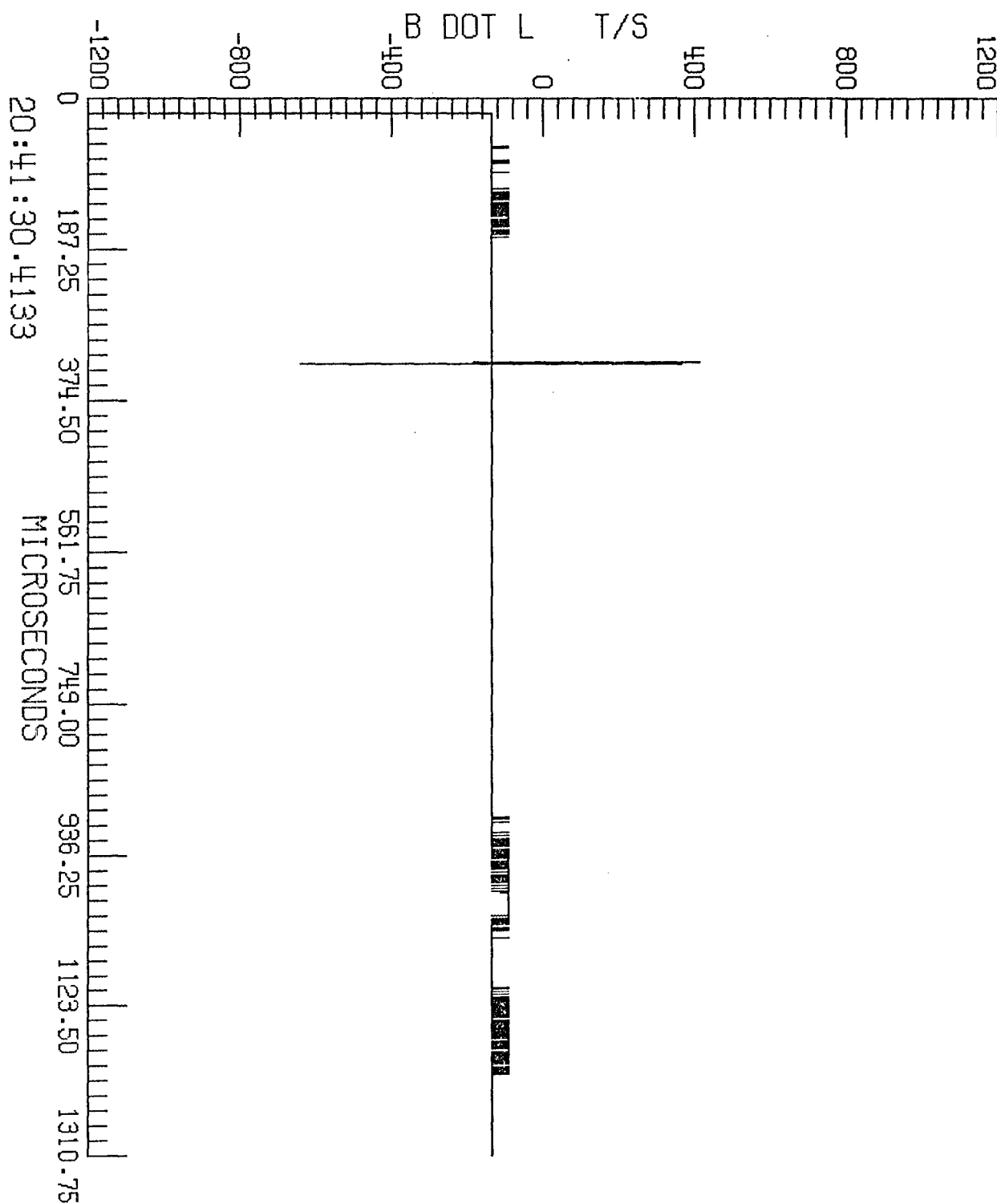
F106 LIGHTNING TK 8/THOMAS
RUN NO. 13 S-011

TEST NO. 83



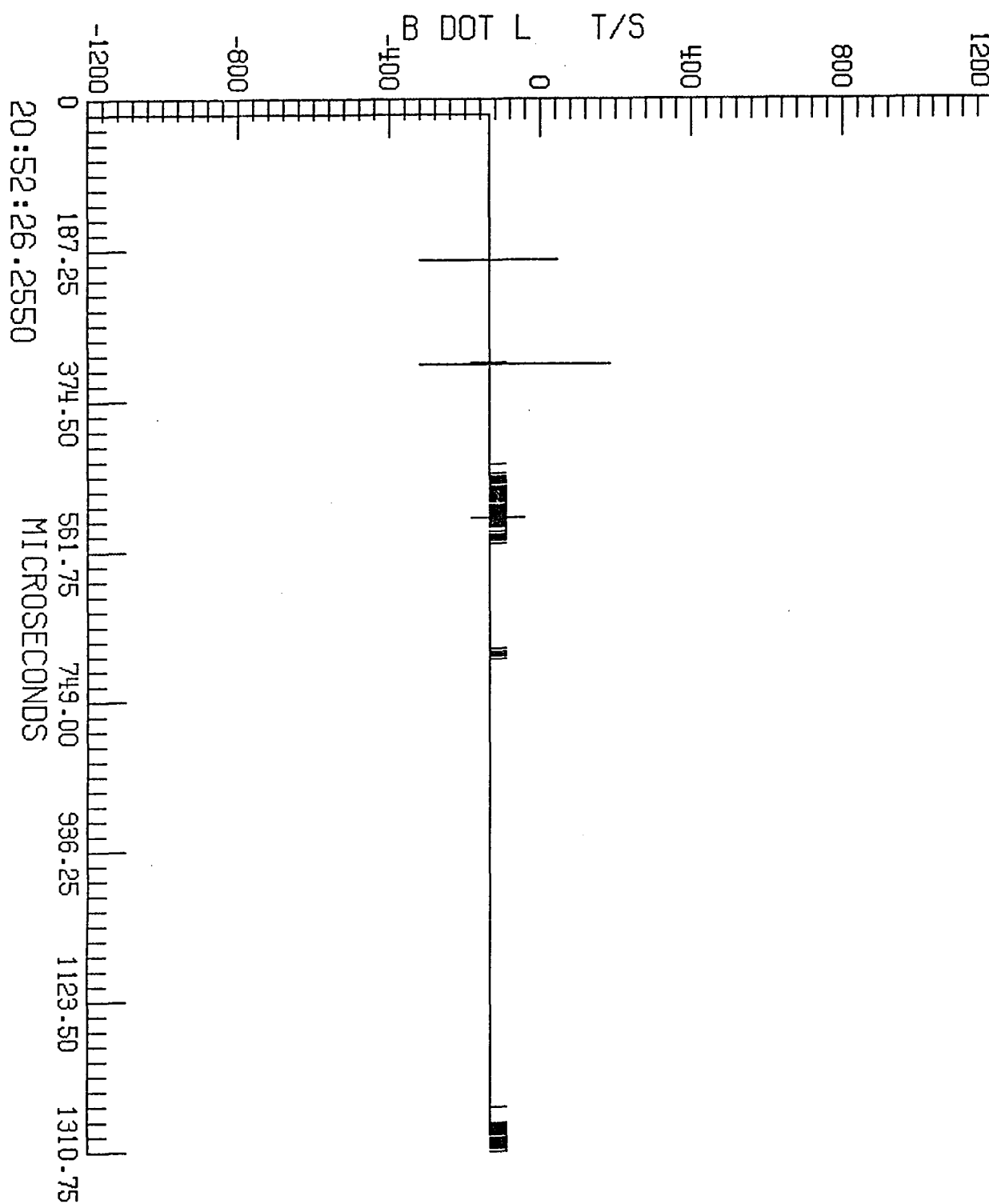
F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 13 S-011

TEST NO. 83-1



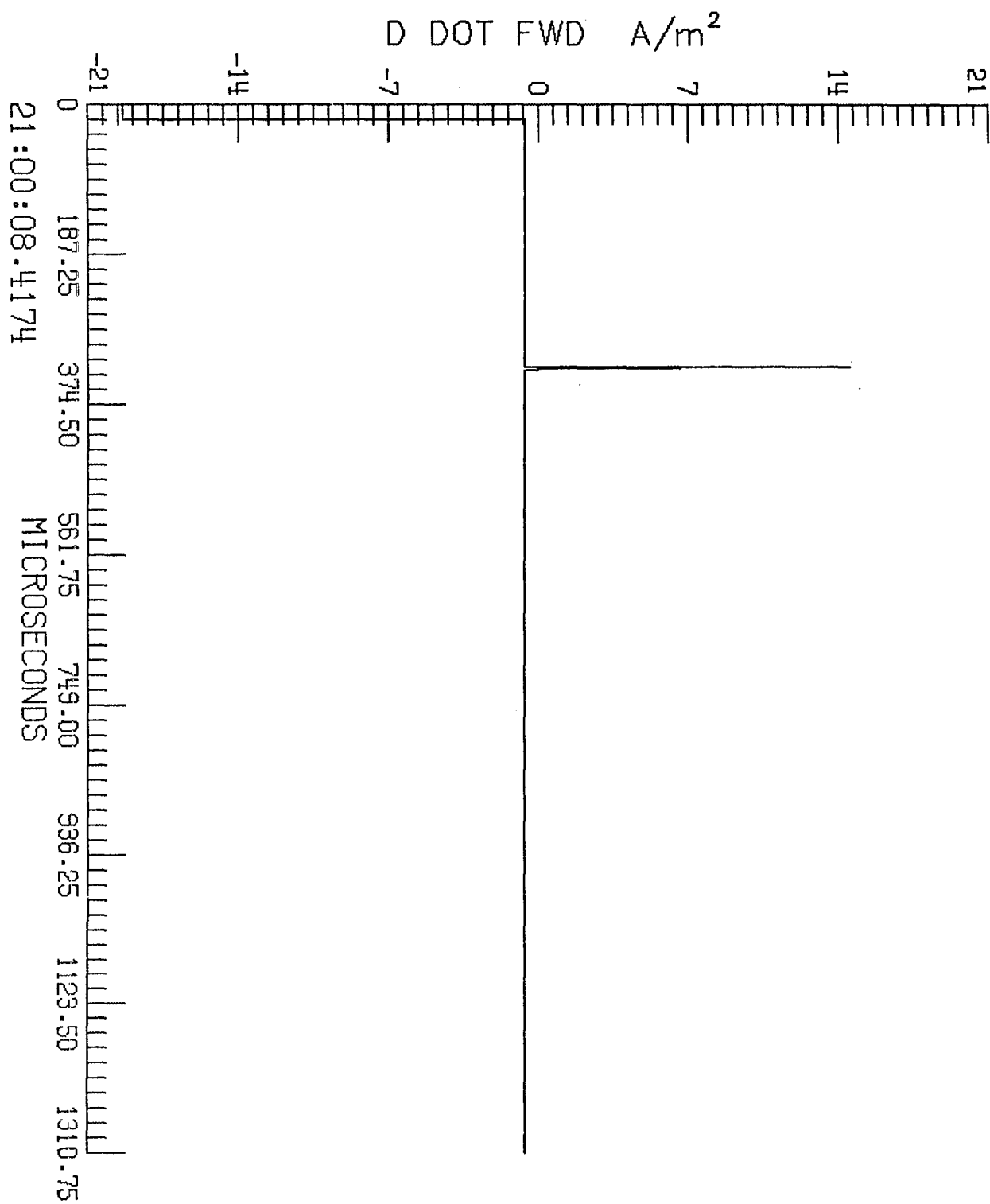
F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 14 N-005

TEST NO. 83-1



F106 LIGHTNING TK 8/THOMAS
RUN NO. 15 N-006

TEST NO. 83

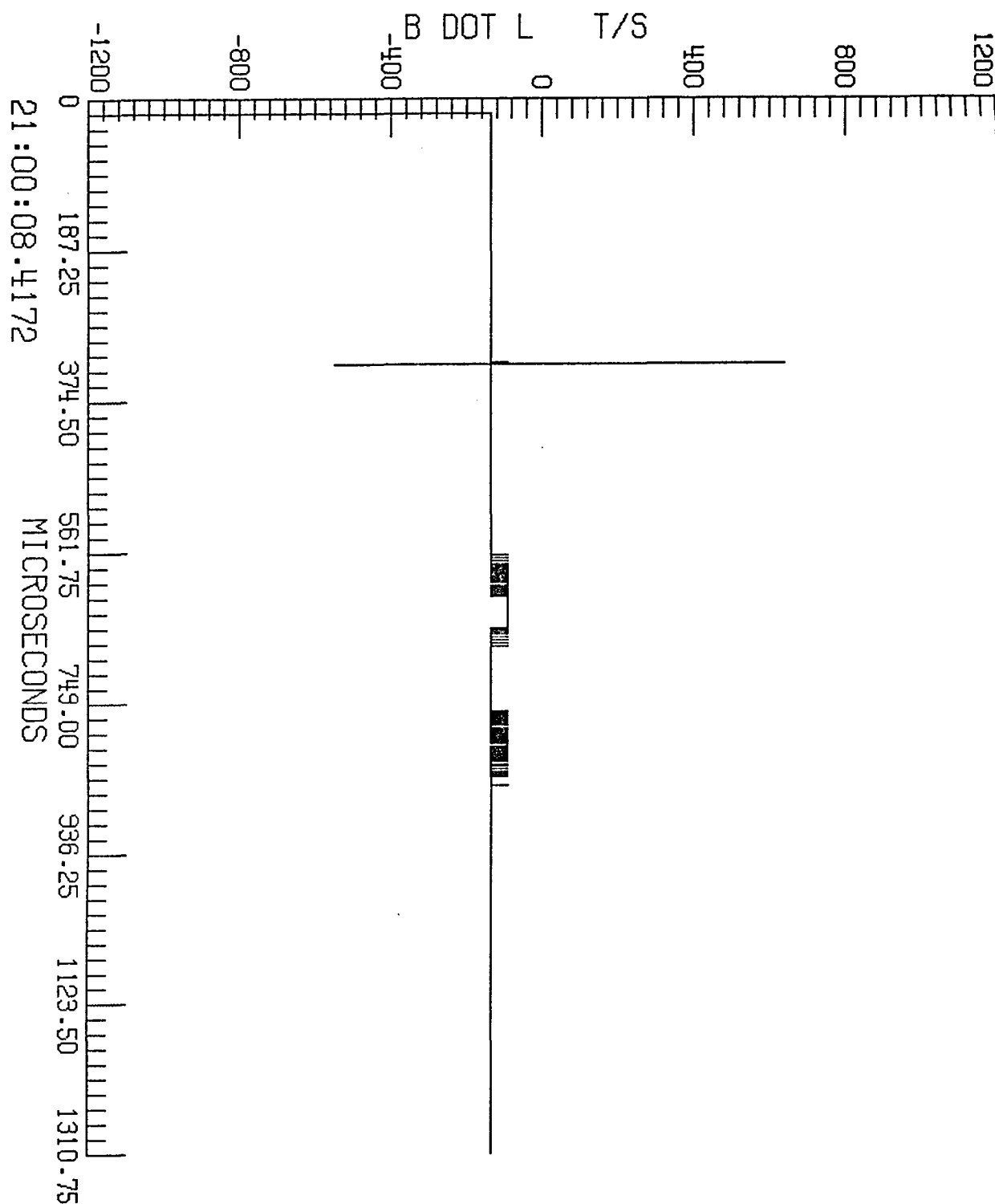


F106 LIGHTNING/TK.10/M.THOMAS

TEST NO. 83-(

RUN NO. 15

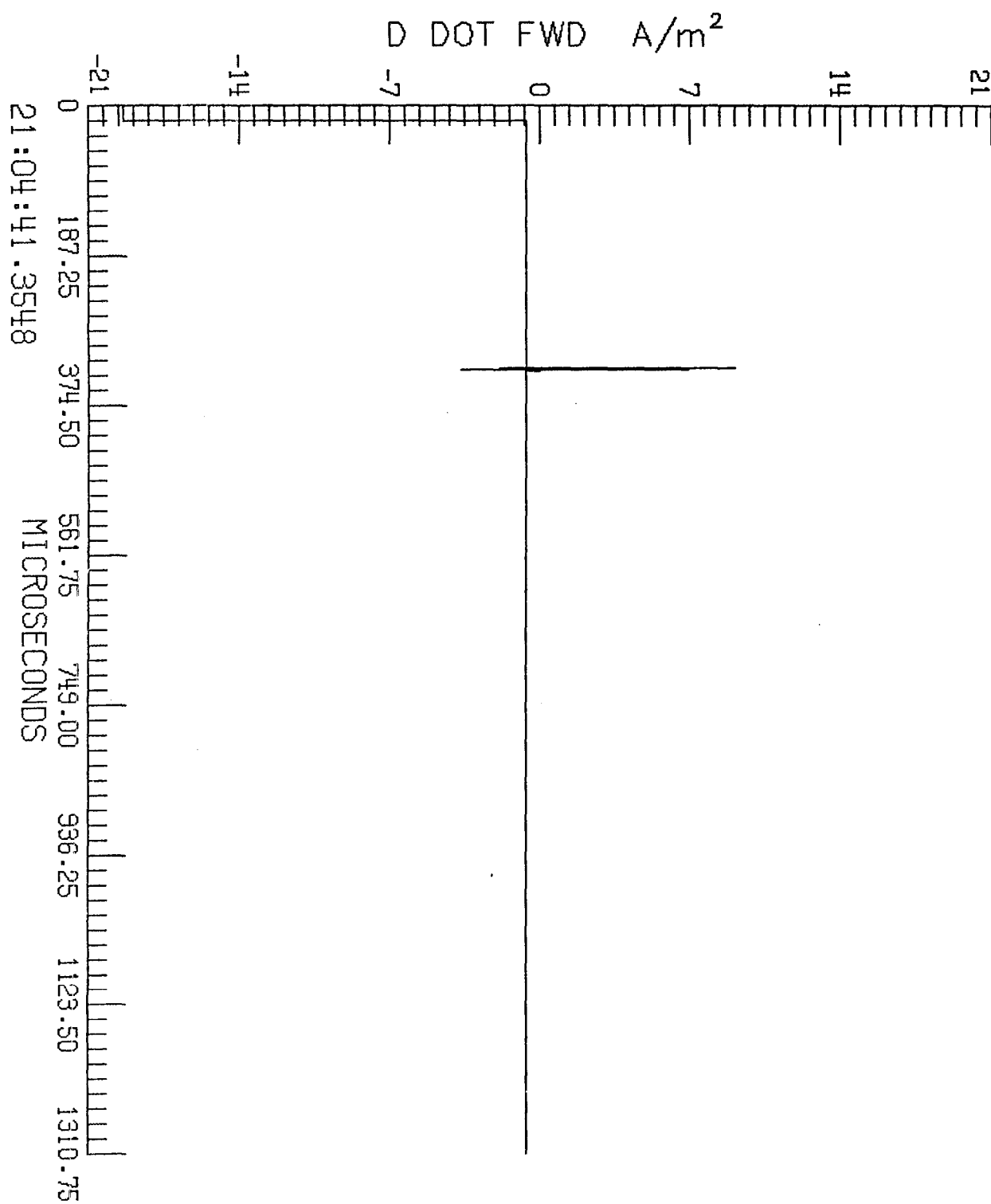
N-006



F106 LIGHTNING TK 8/THOMAS
RUN NO. 16

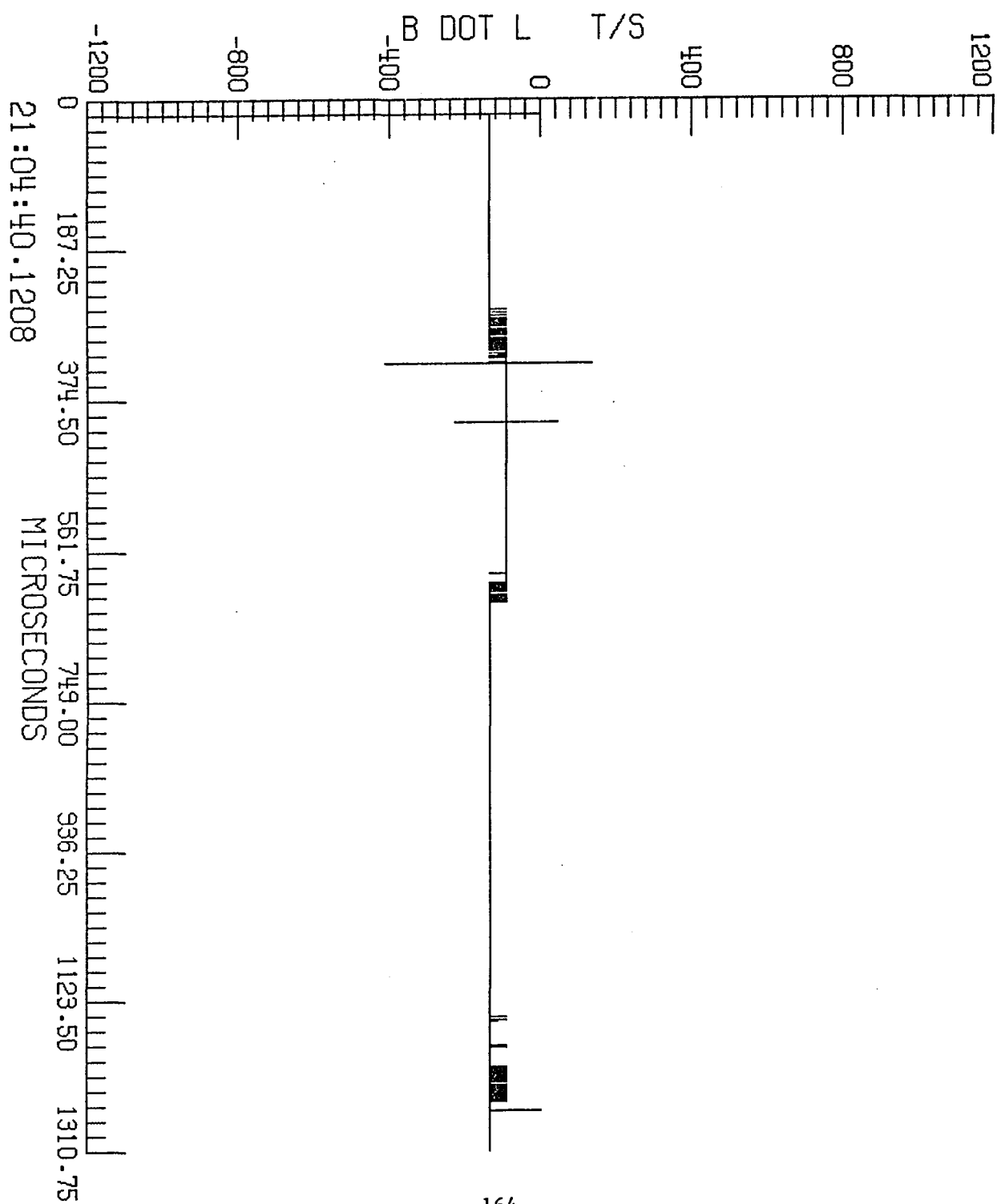
S-012

TEST NO. 83



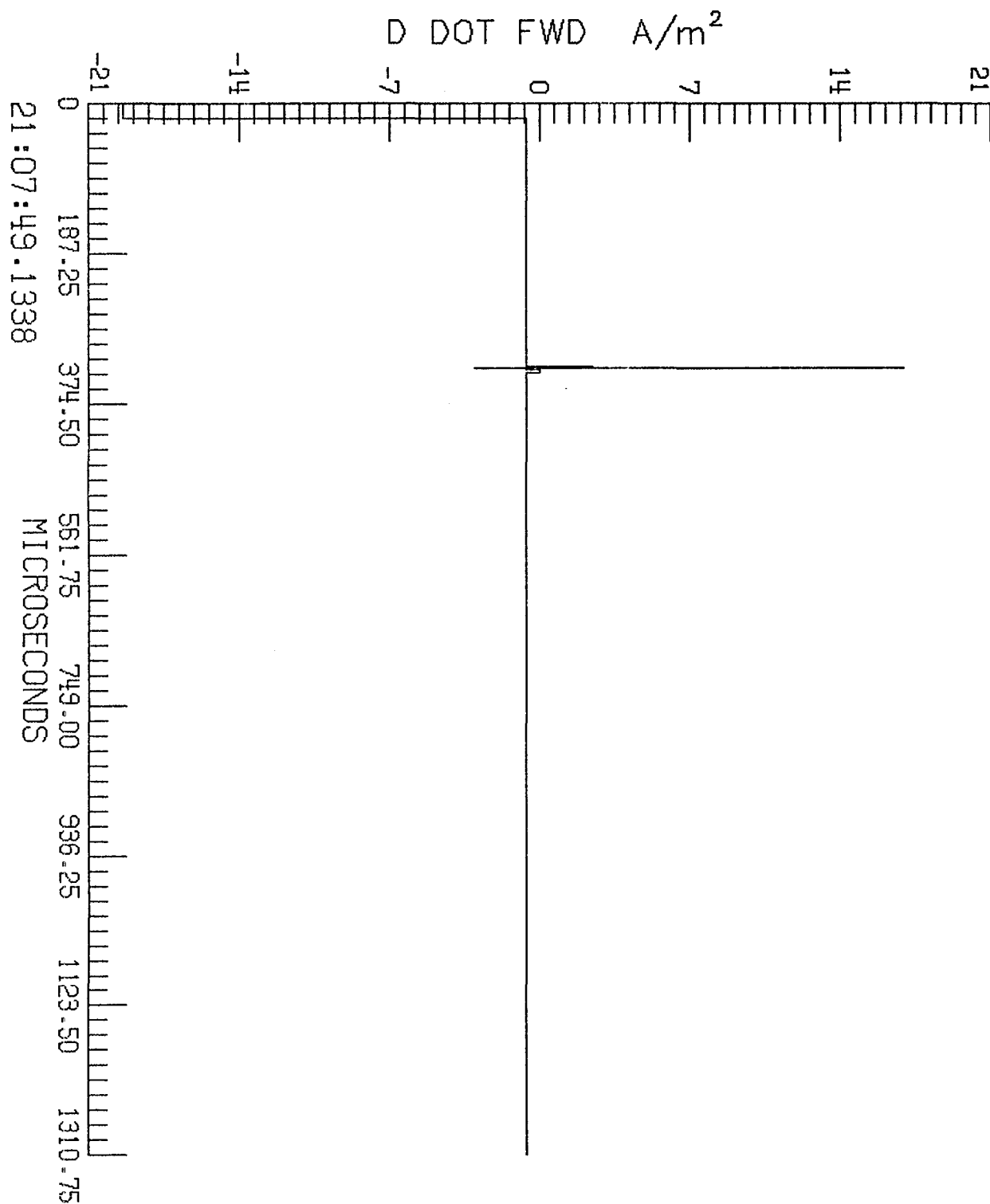
F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 16 S-012

TEST NO. 83-1



F106 LIGHTNING TK 8/THOMAS
RUN NO. 17 N-007

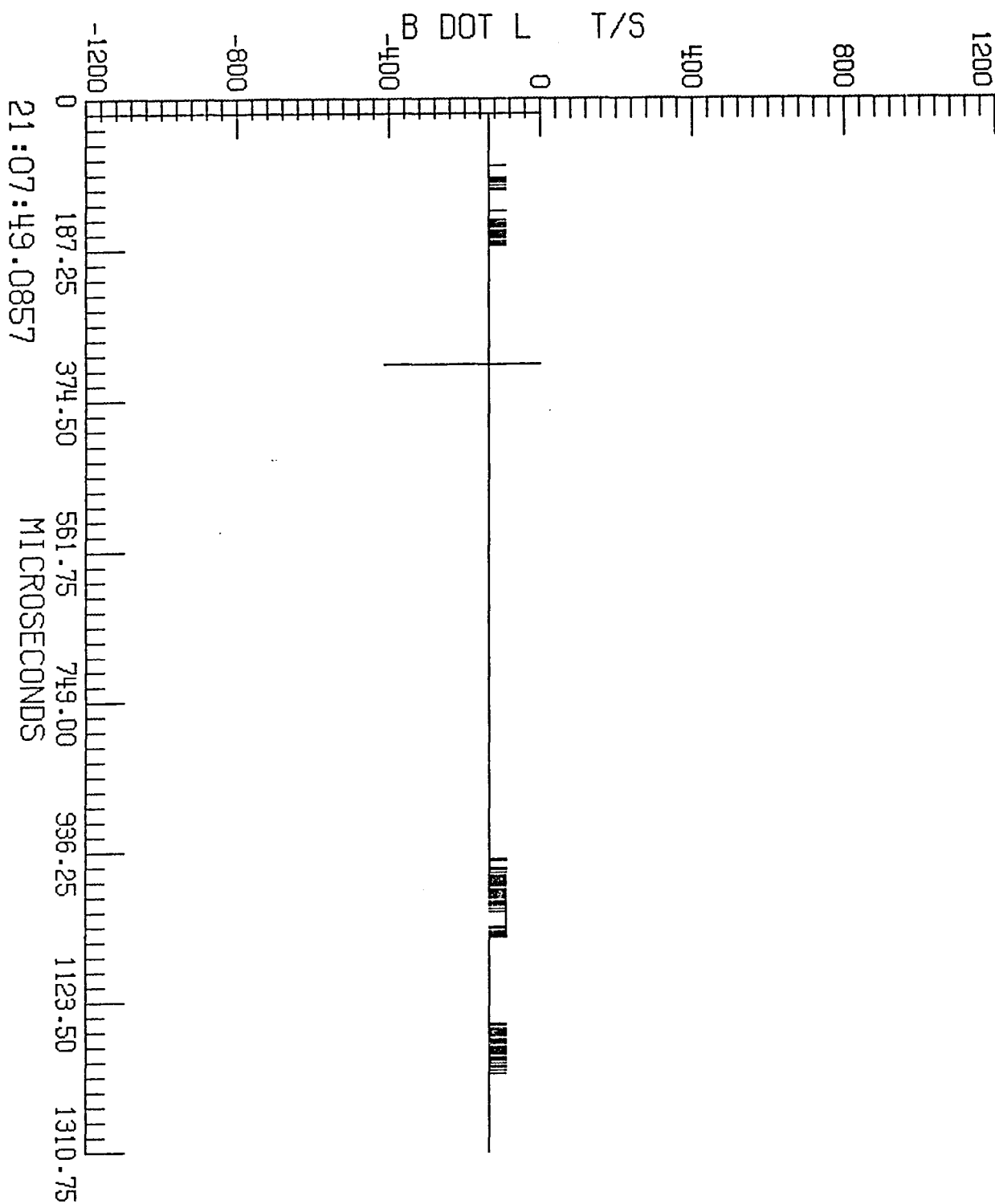
TEST NO. 83



F106 LIGHTNING/TK.10/M.THOMAS
RUN NO. 17

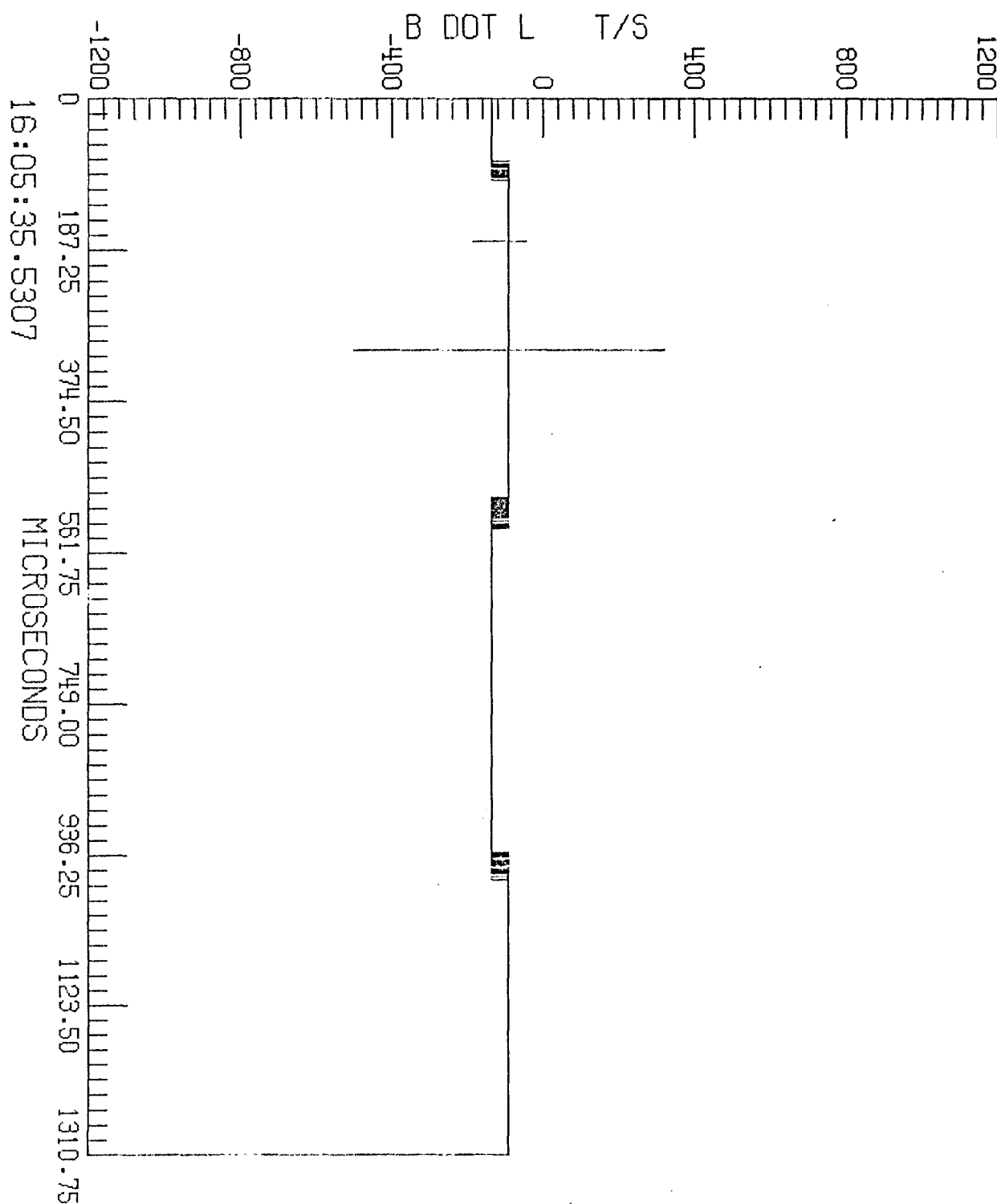
TEST NO. 83-I

N-007



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 1 N-001

TEST NO. 83

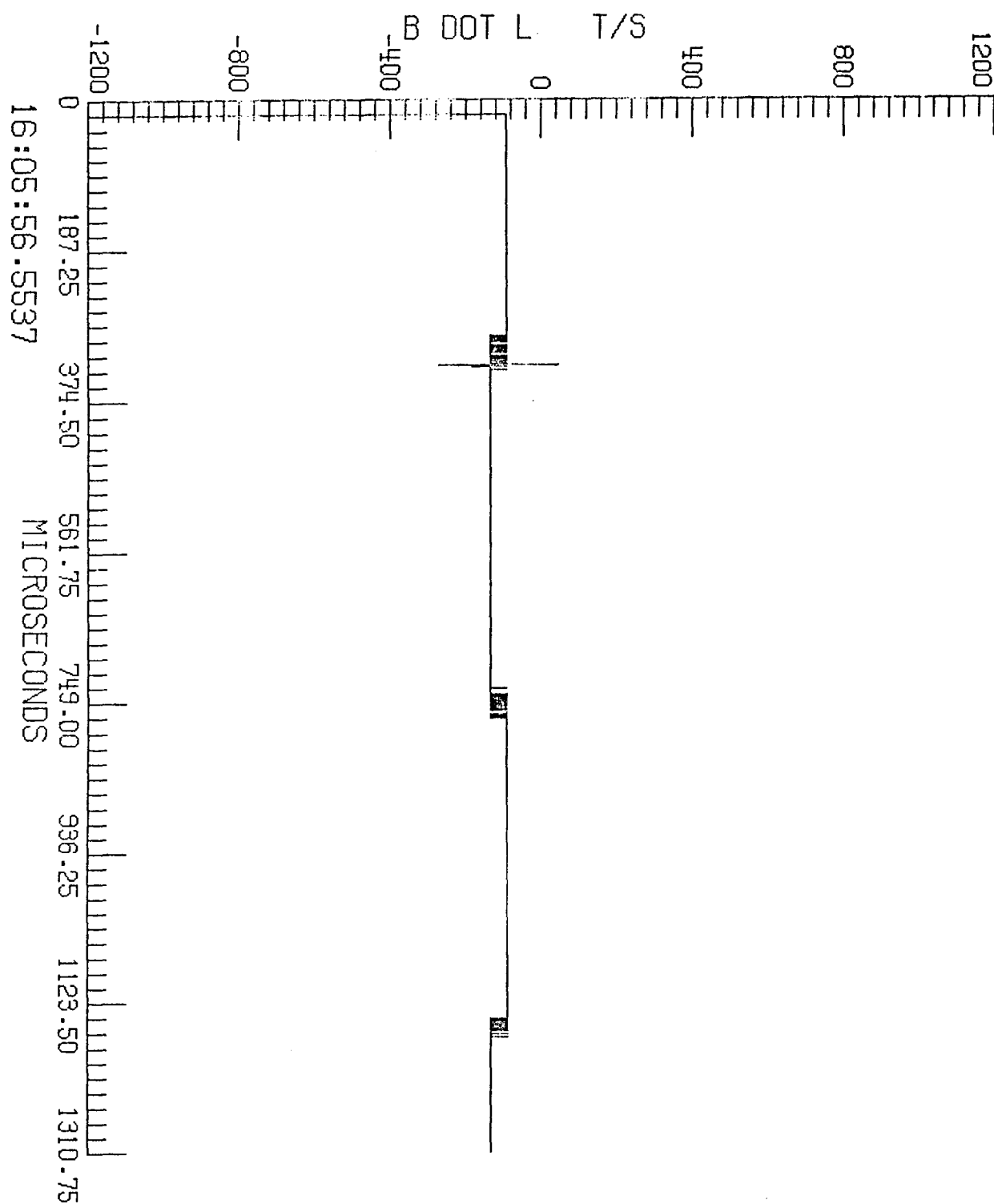


F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83

RUN NO. 2

N-002

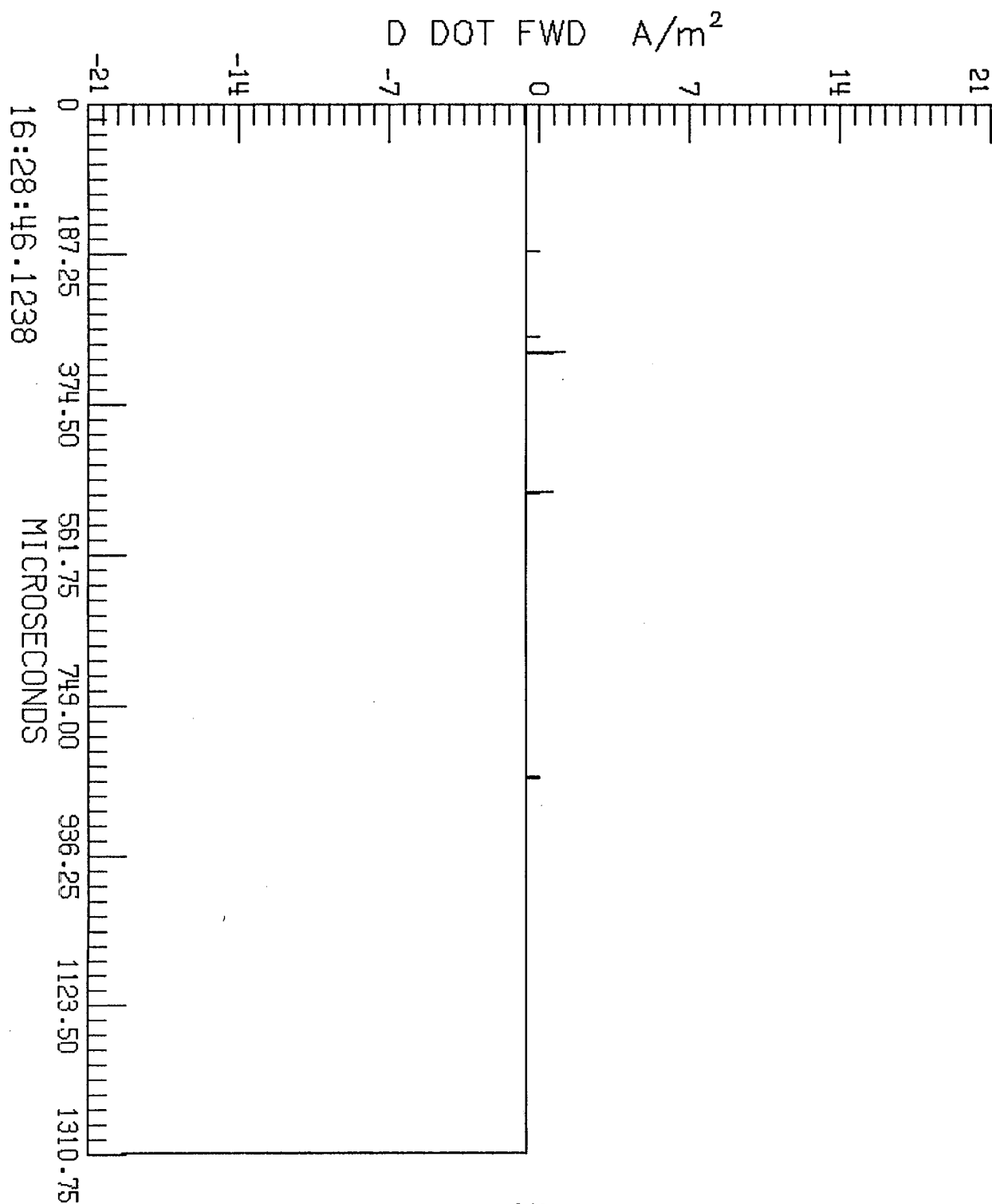


F106 LIGHTNING/TK 8/M. THOMAS

TEST NO. 83

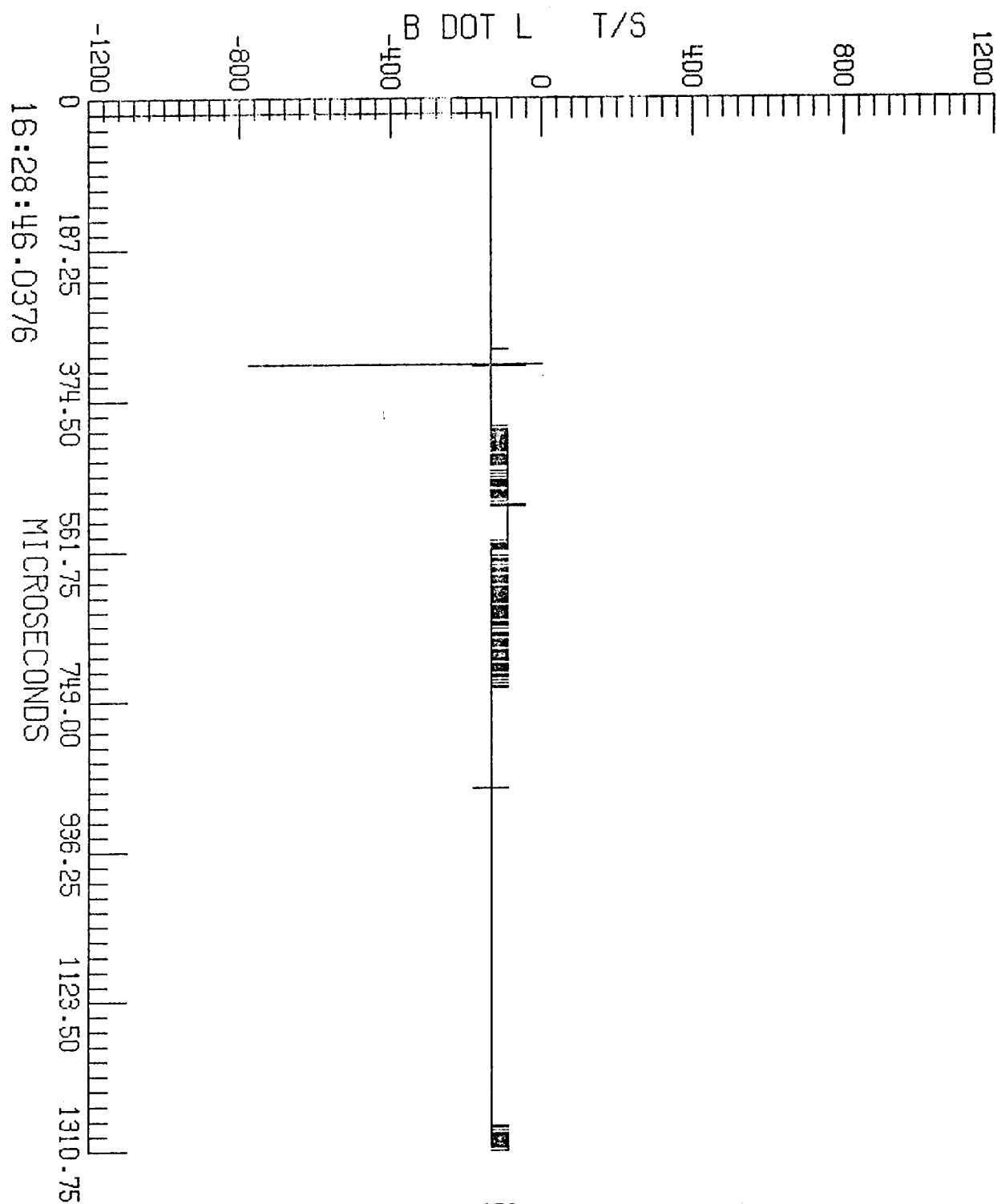
RUN NO. 3

N-003



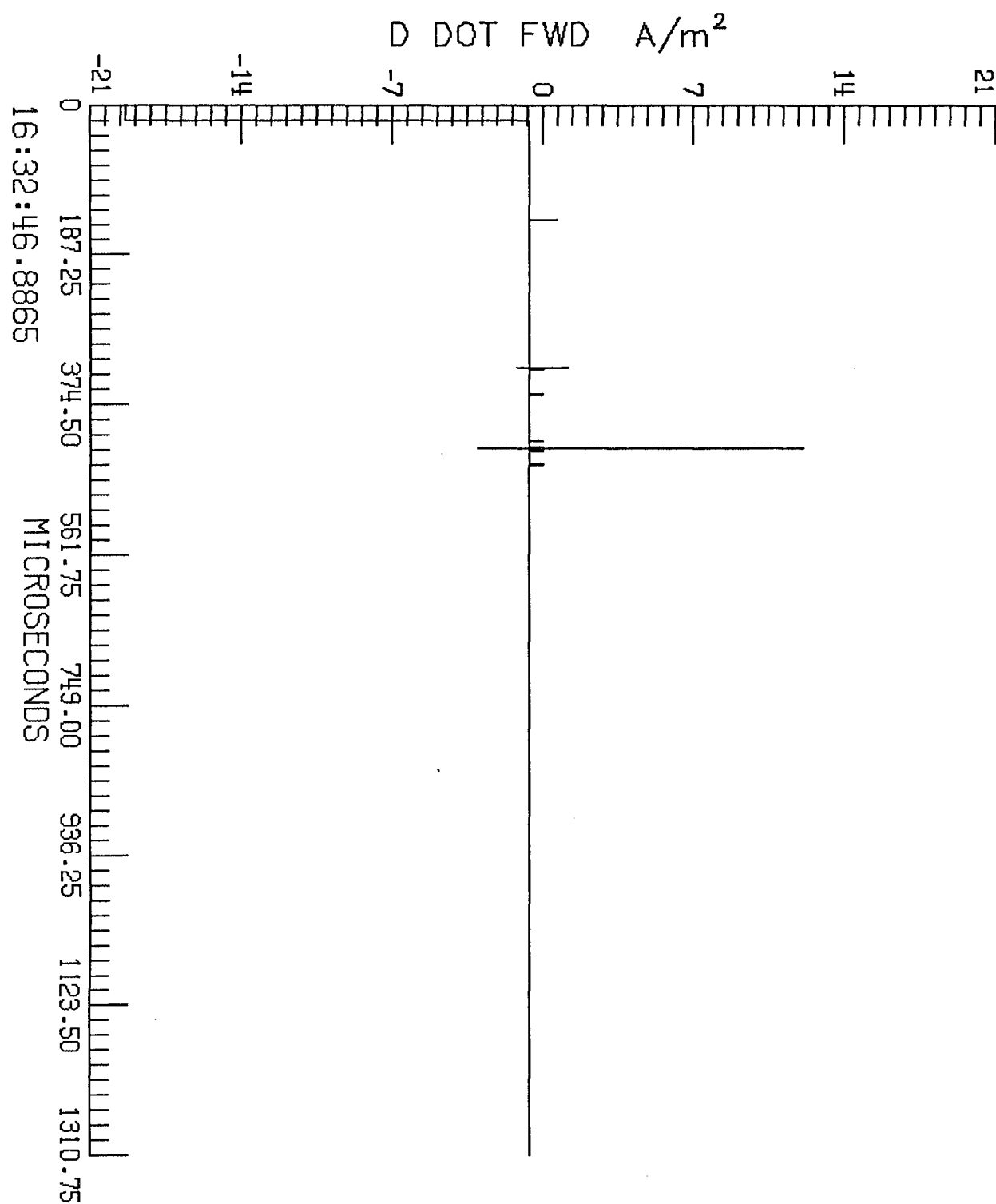
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 3 N-003

TEST NO. 83



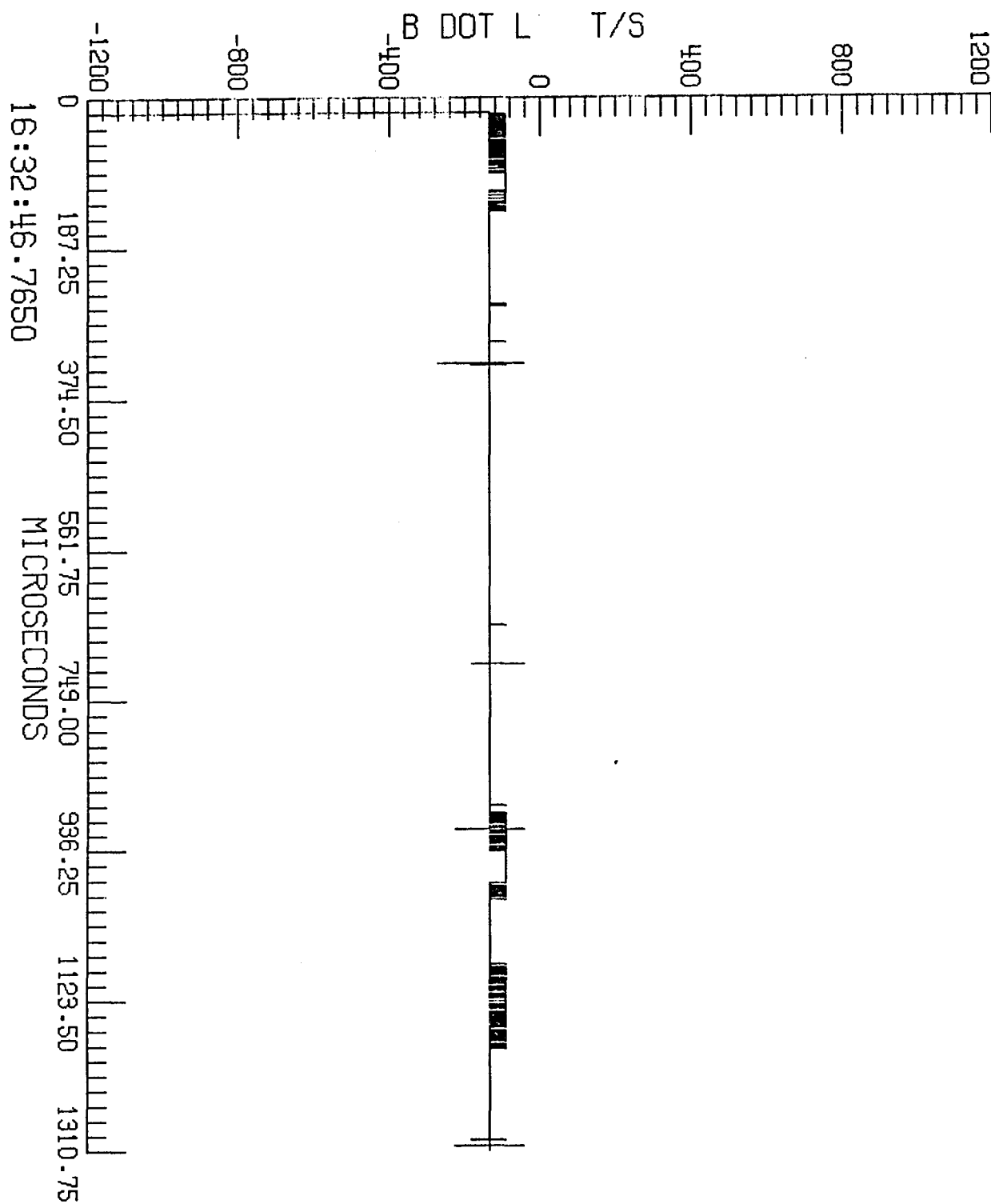
F106 LIGHTNING/TK 8/M. THOMAS
RUN NO. 4 S-002

TEST NO. 83



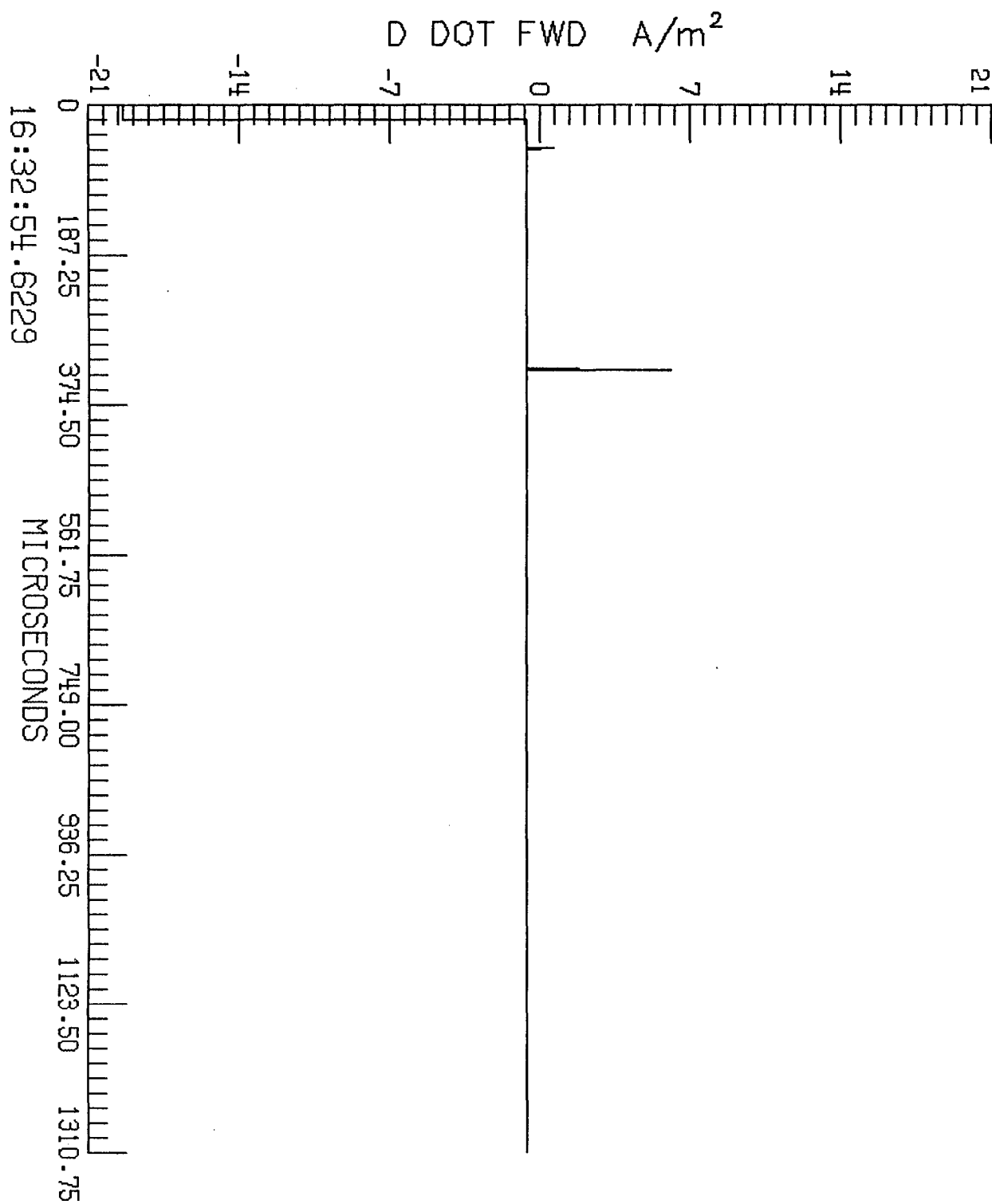
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 4 S-002

TEST NO. 83



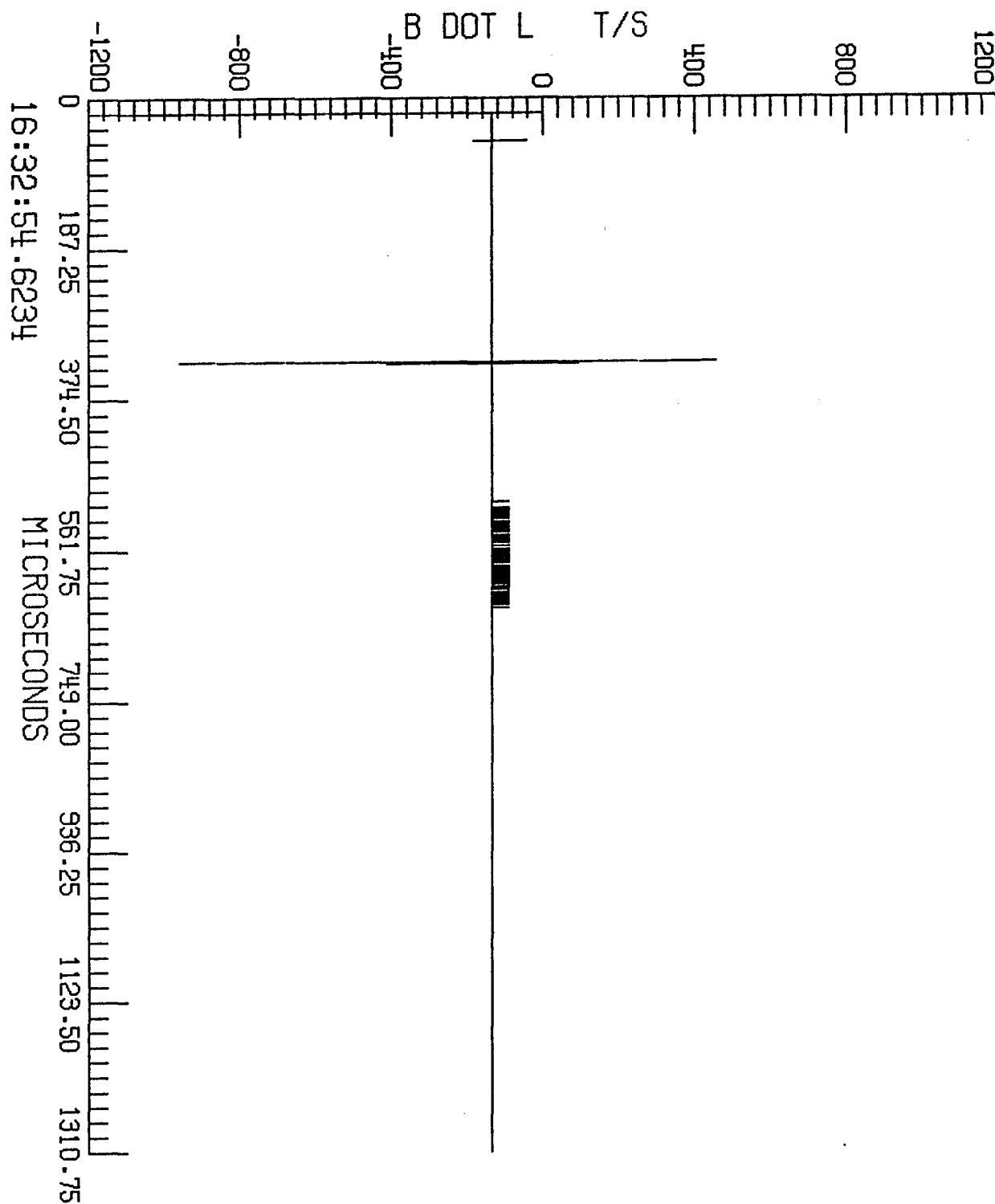
F106 LIGHTNING/TK 8/M. THOMAS
RUN NO. 5 S-003

TEST NO. 83



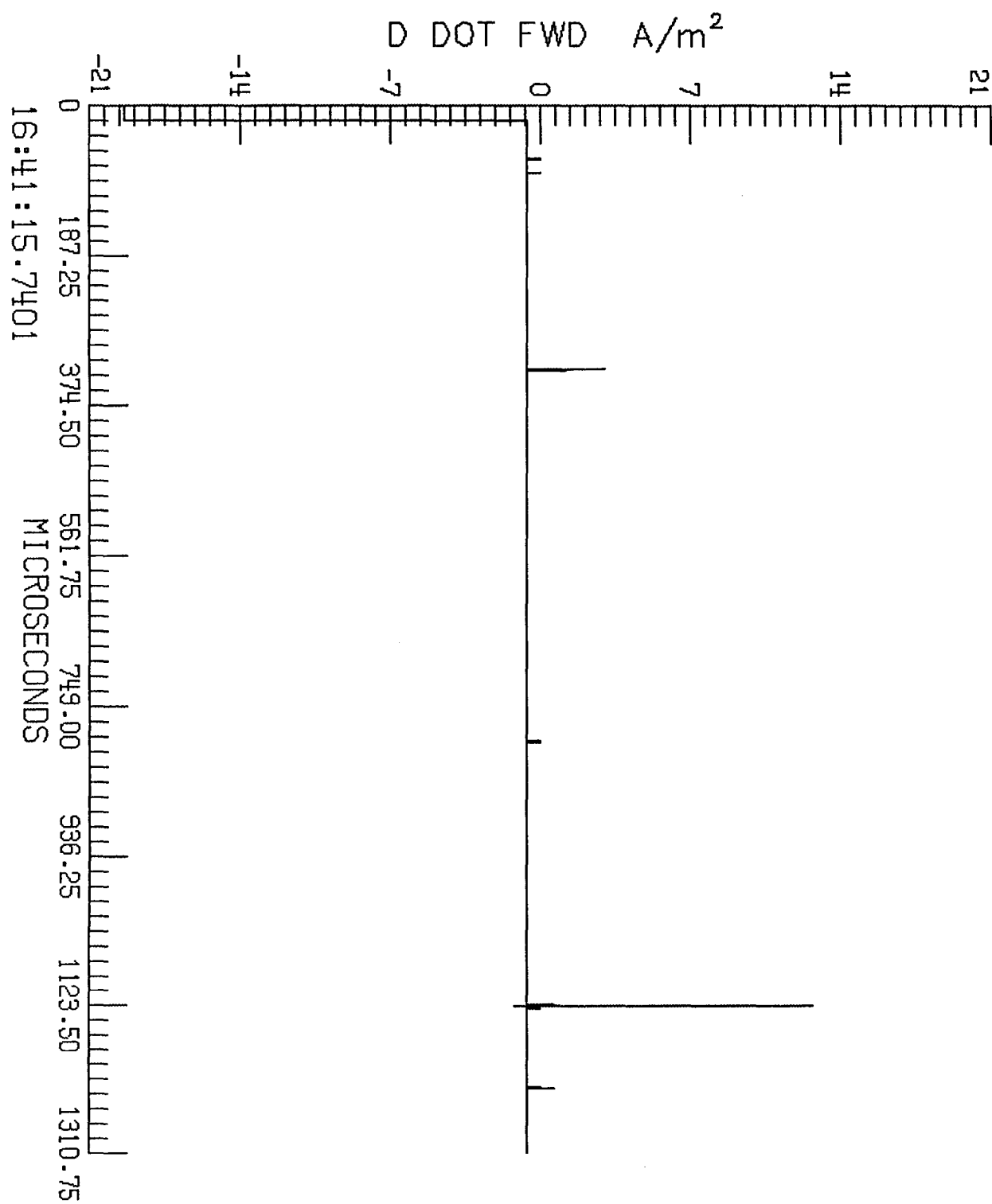
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 5 S-003

TEST NO. 83



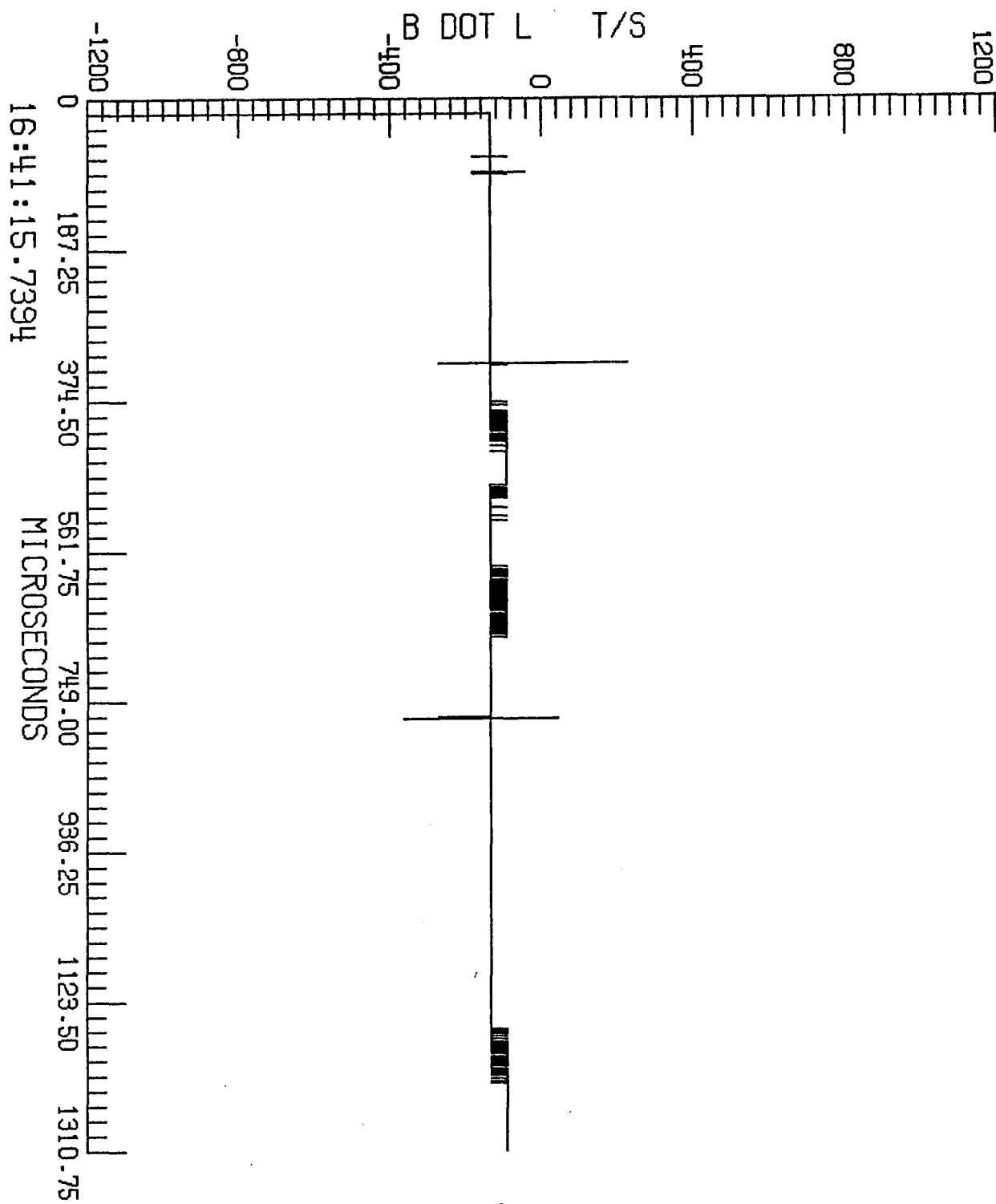
F106 LIGHTNING/TK 8/M. THOMAS
RUN NO. 6 S-004

TEST NO. 83



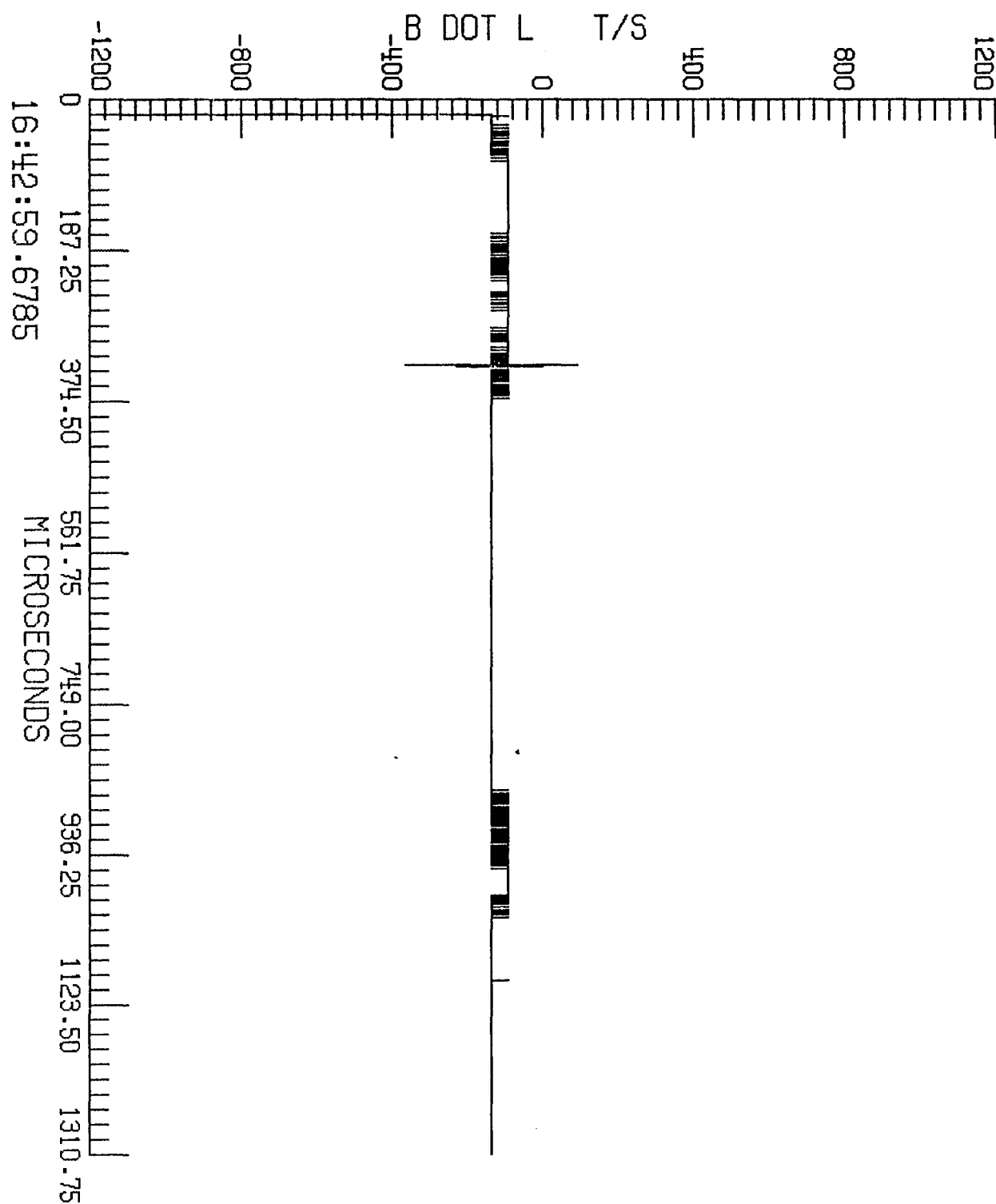
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 6 S-004

TEST NO. 83



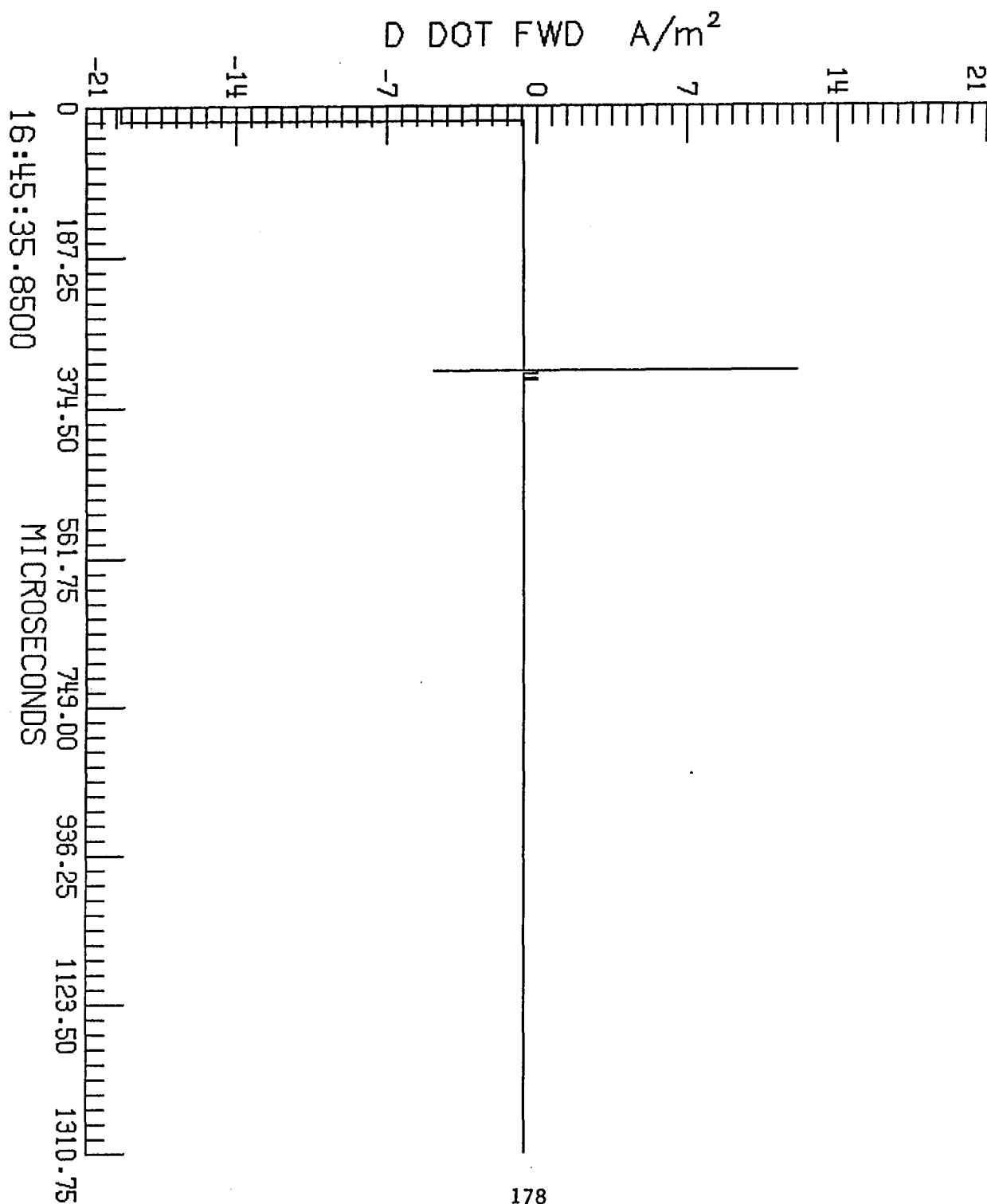
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 7 N-004

TEST NO. 83



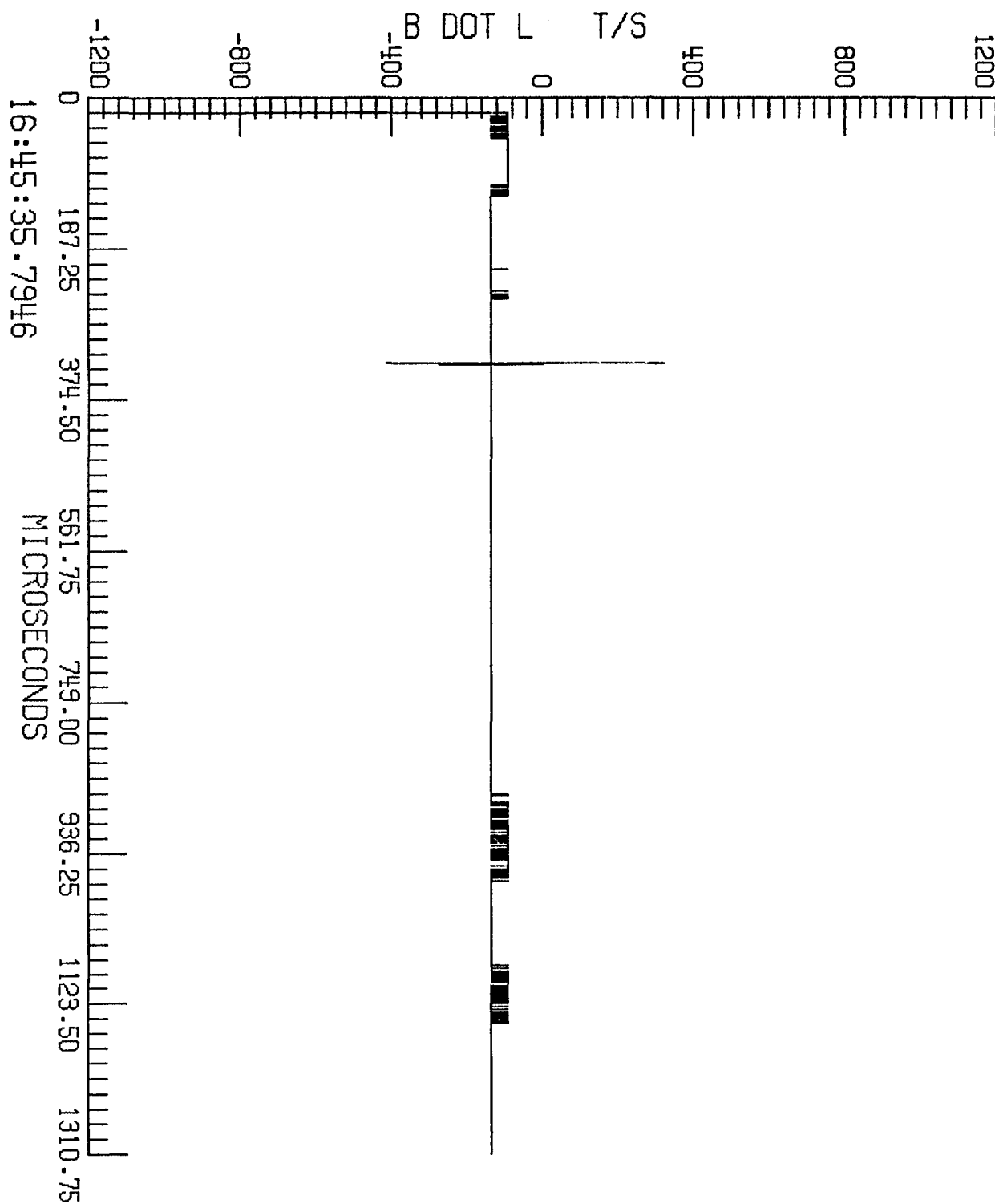
F106 LIGHTNING/TK 8/M. THOMAS
RUN NO. 8 S-005

TEST NO. 83



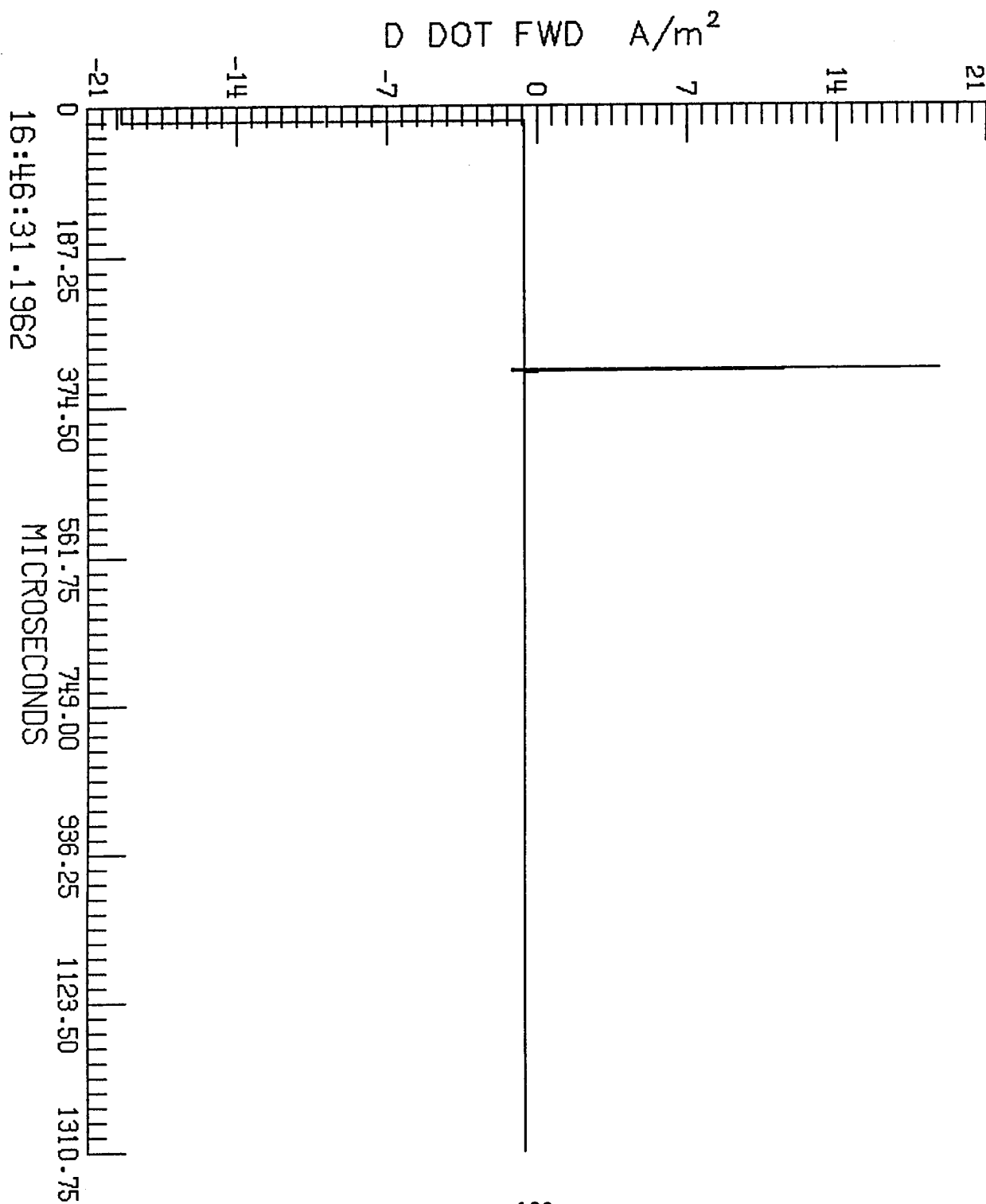
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 8 S-005

TEST NO. 83



F106 LIGHTNING/TK 8/M. THOMAS
RUN NO. 9 S-006

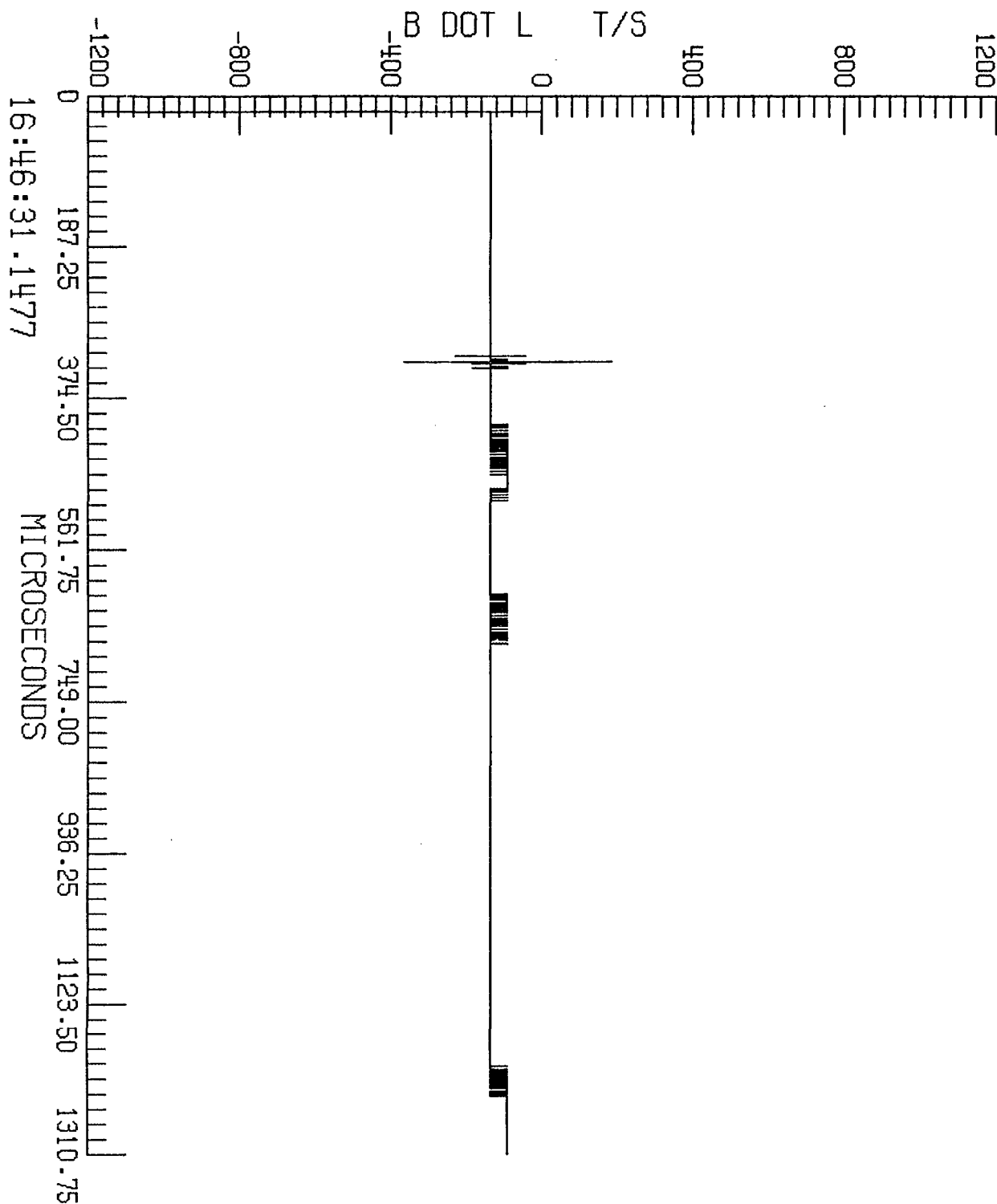
TEST NO. 83-



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 9

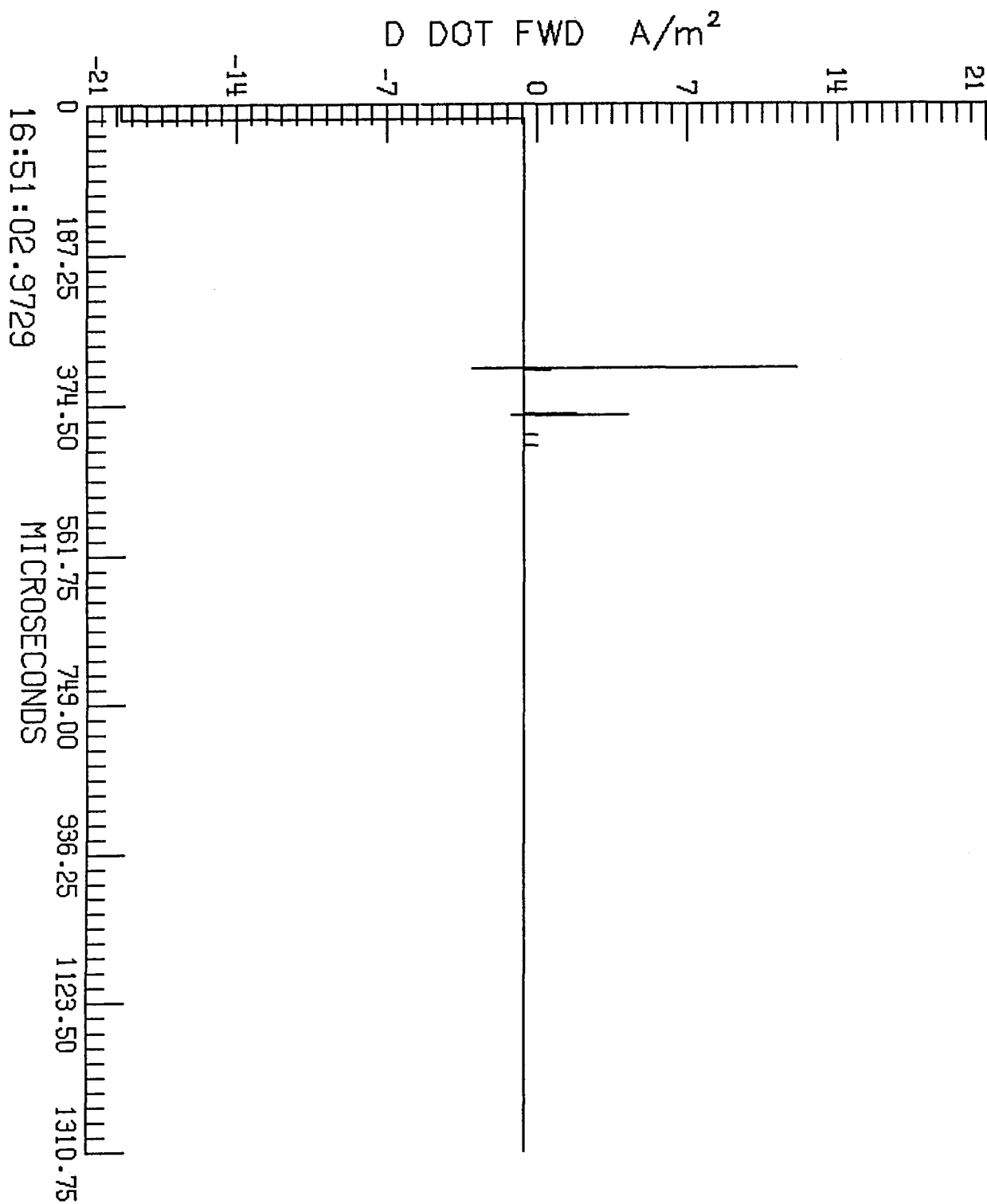
TEST NO. 83-

S-006



F106 LIGHTNING/TK 8/M. THOMAS
RUN NO. 10 S-007

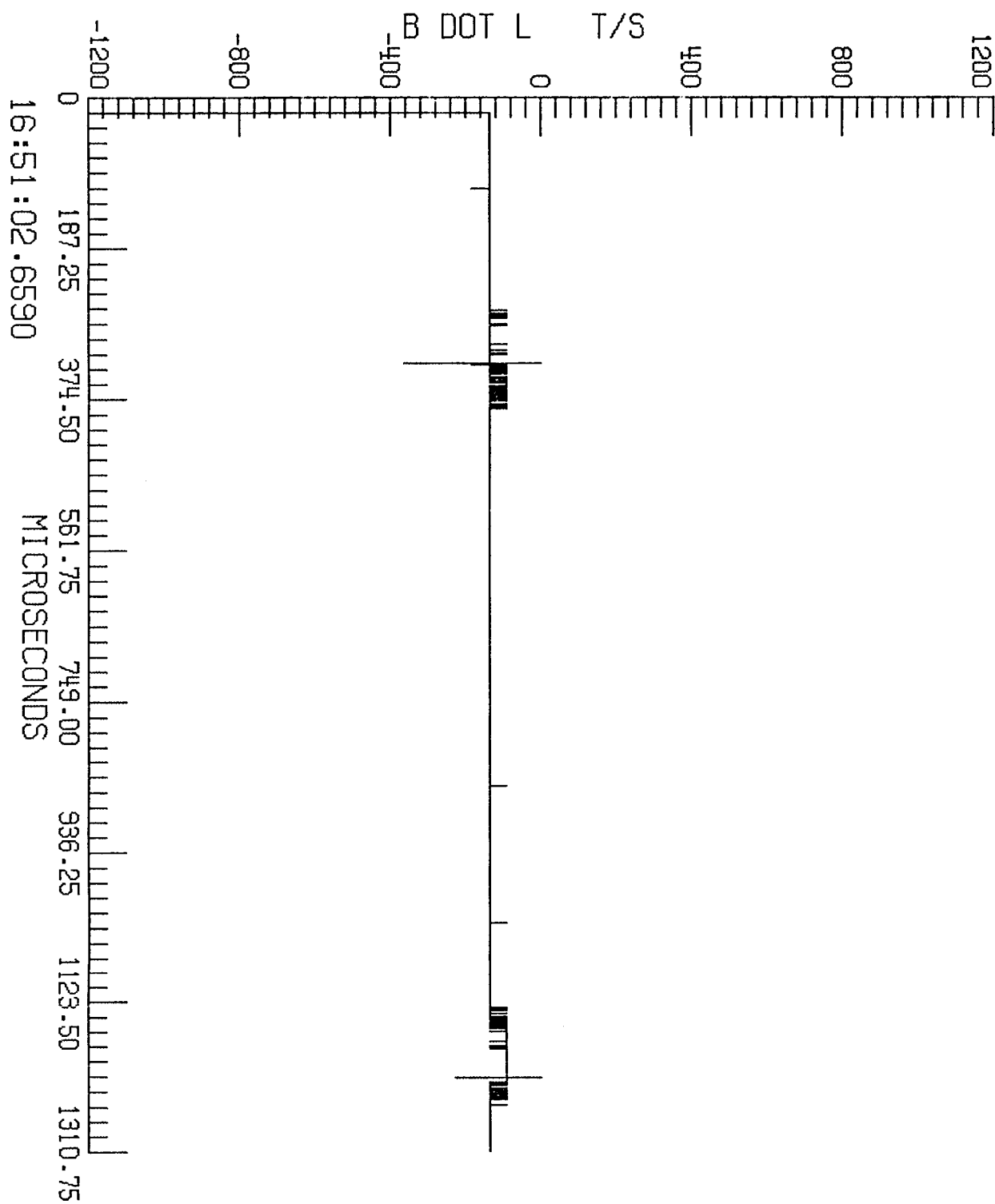
TEST NO. 83-



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 10

TEST NO. 83-

S-007

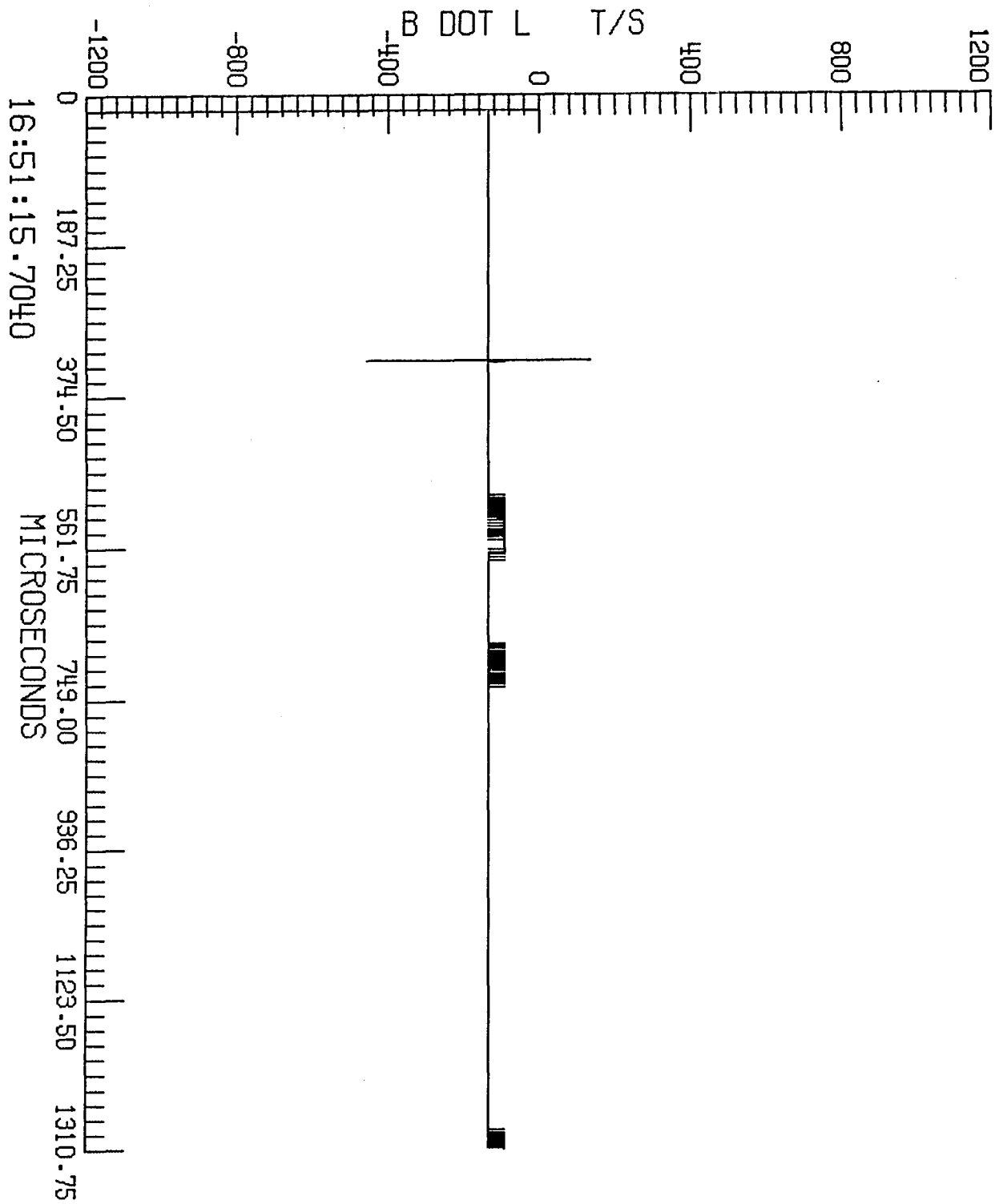


F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83-

RUN NO. 11

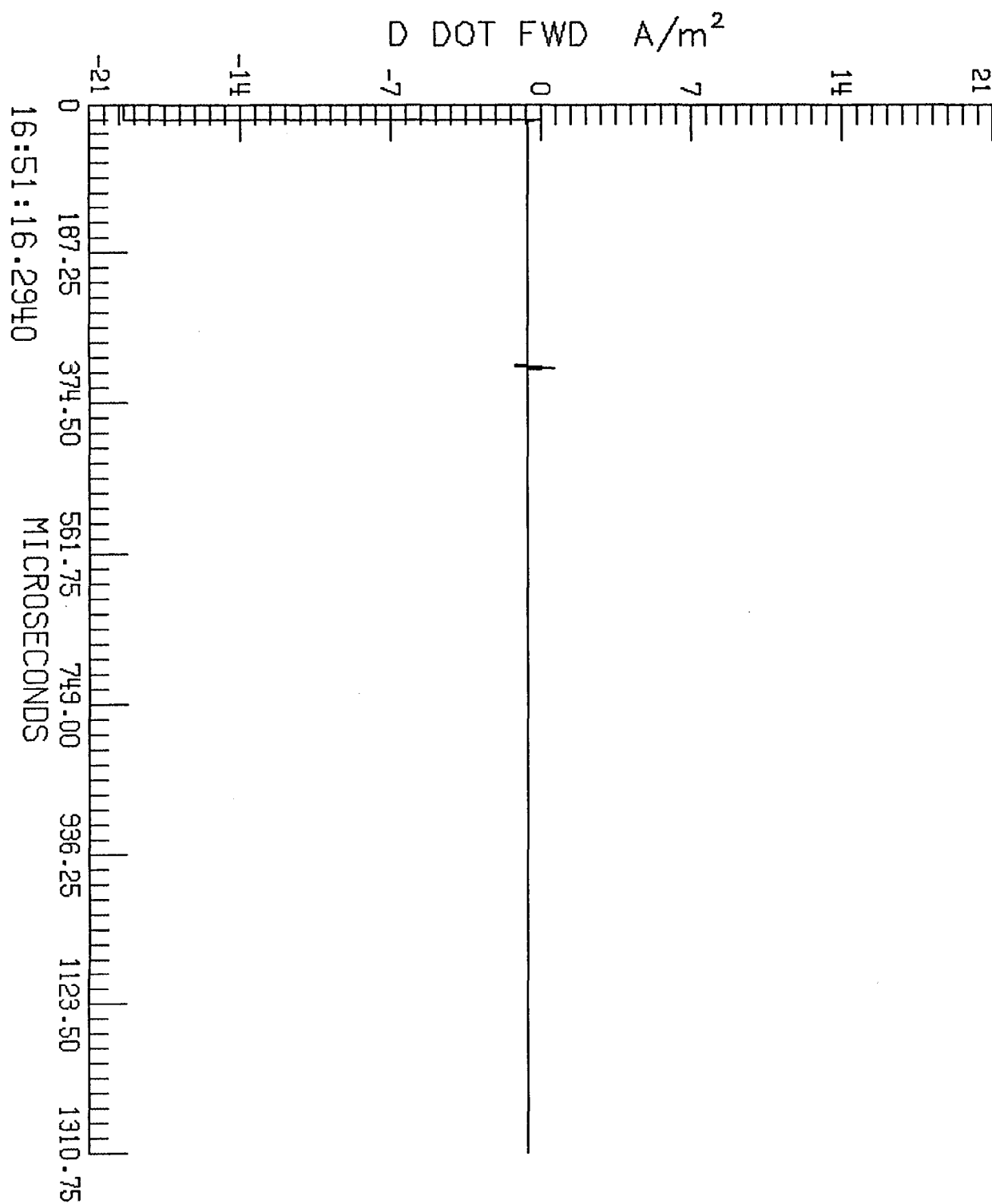
N-005



F106 LIGHTNING/TK 8/M. THOMAS
RUN NO. 11

N-006

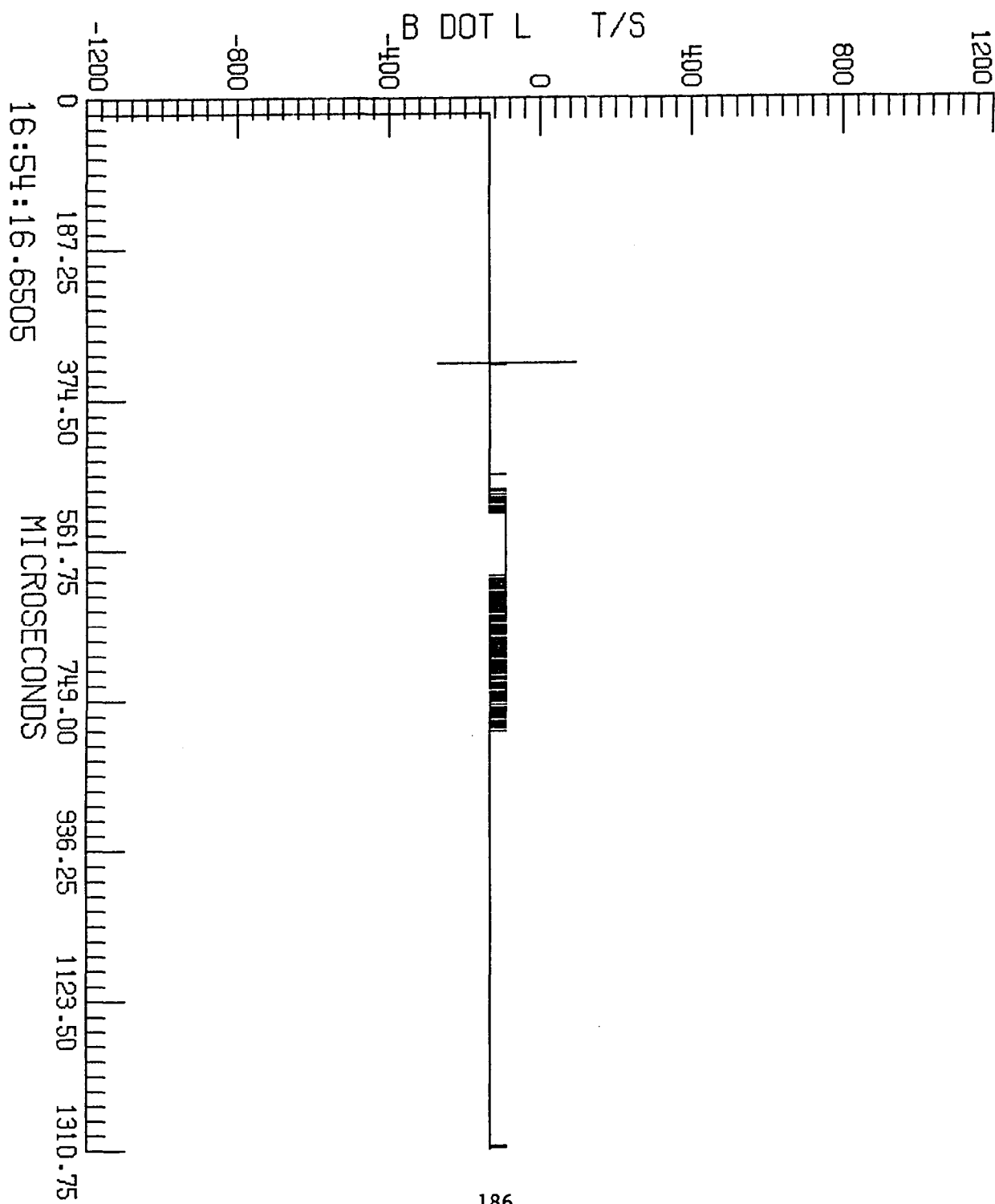
TEST NO. 83-



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 12

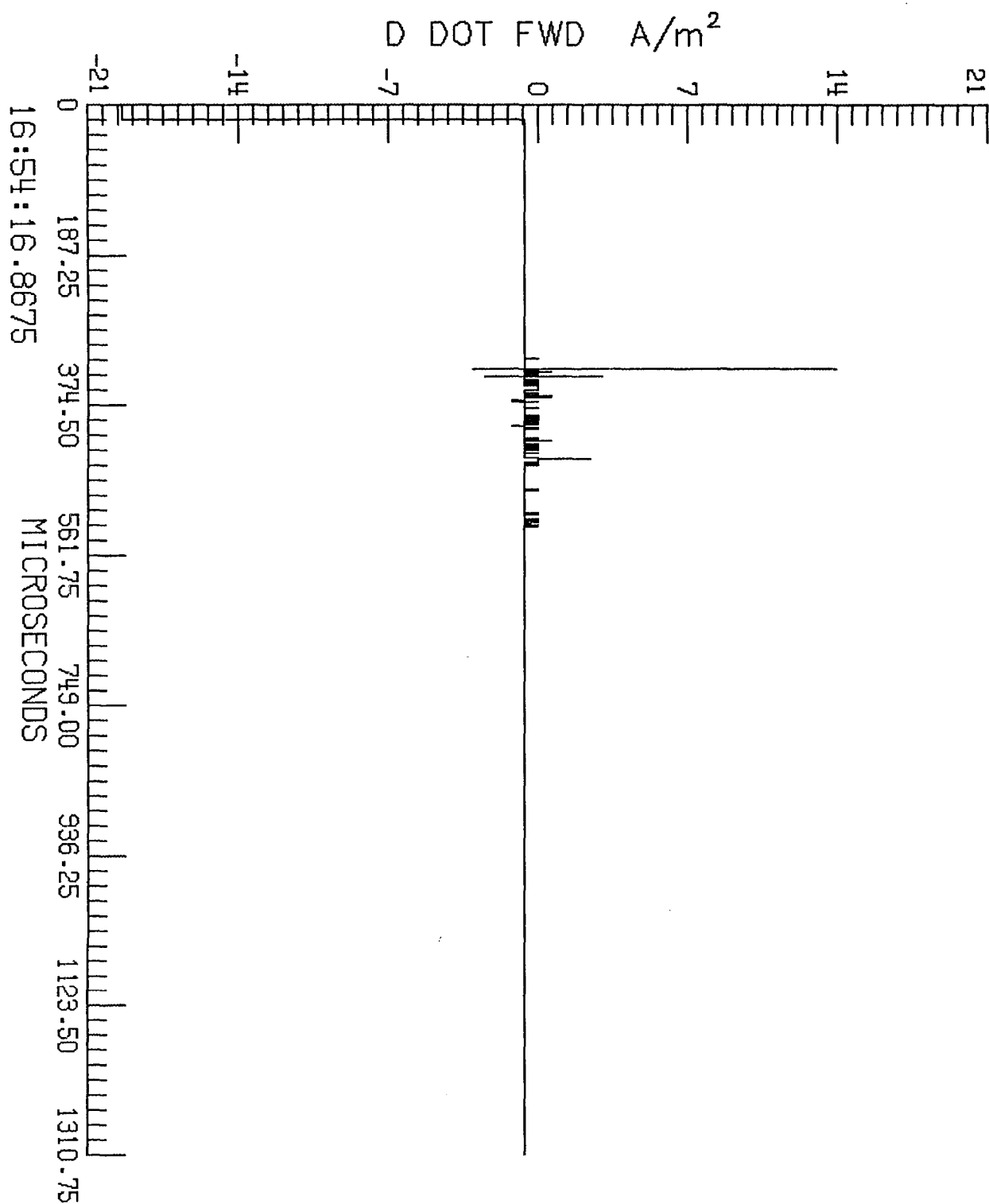
TEST NO. 83-

N-007



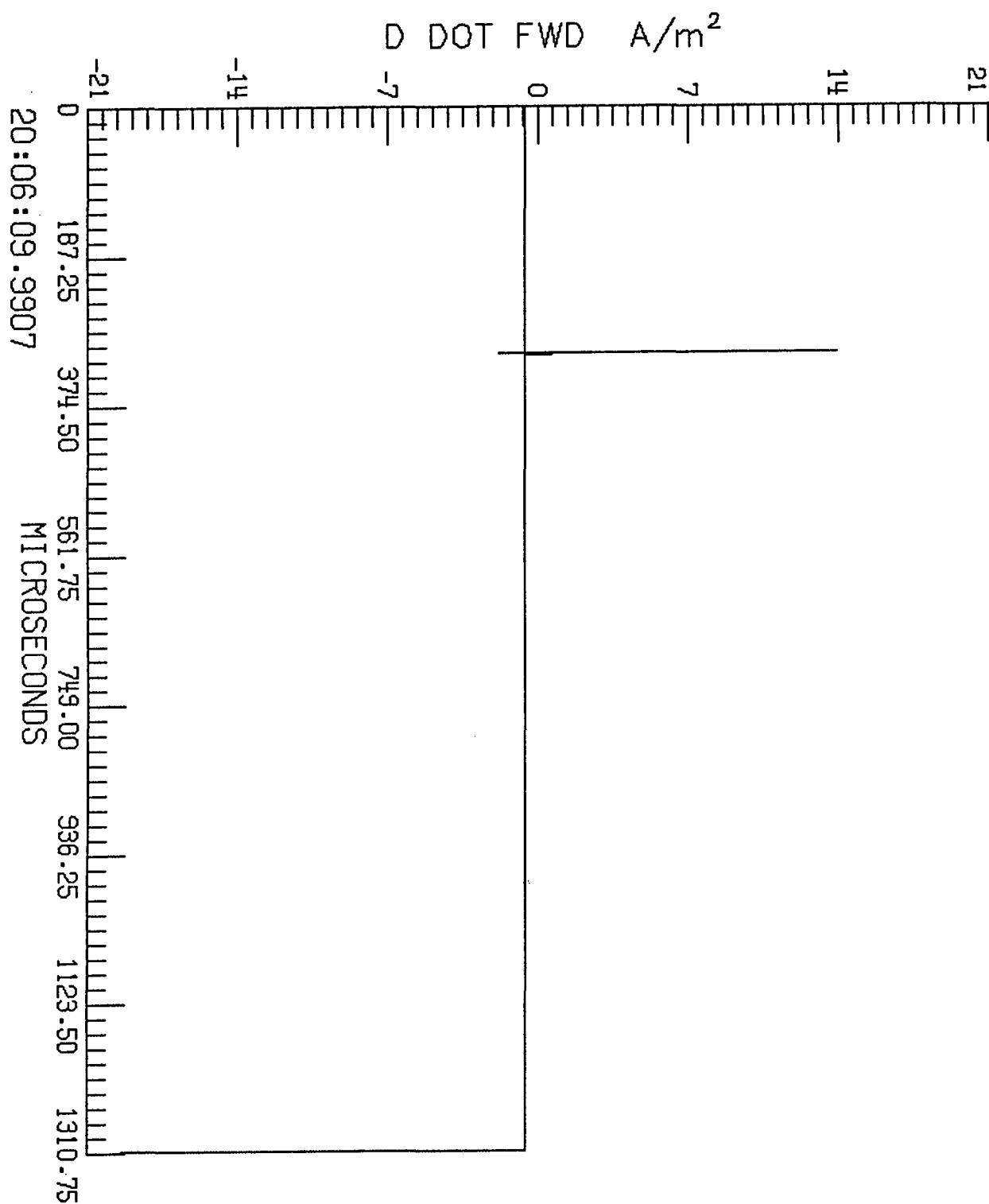
F106 LIGHTNING/TK 8/M. THOMAS
RUN NO. 12 S-008

TEST NO. 83-



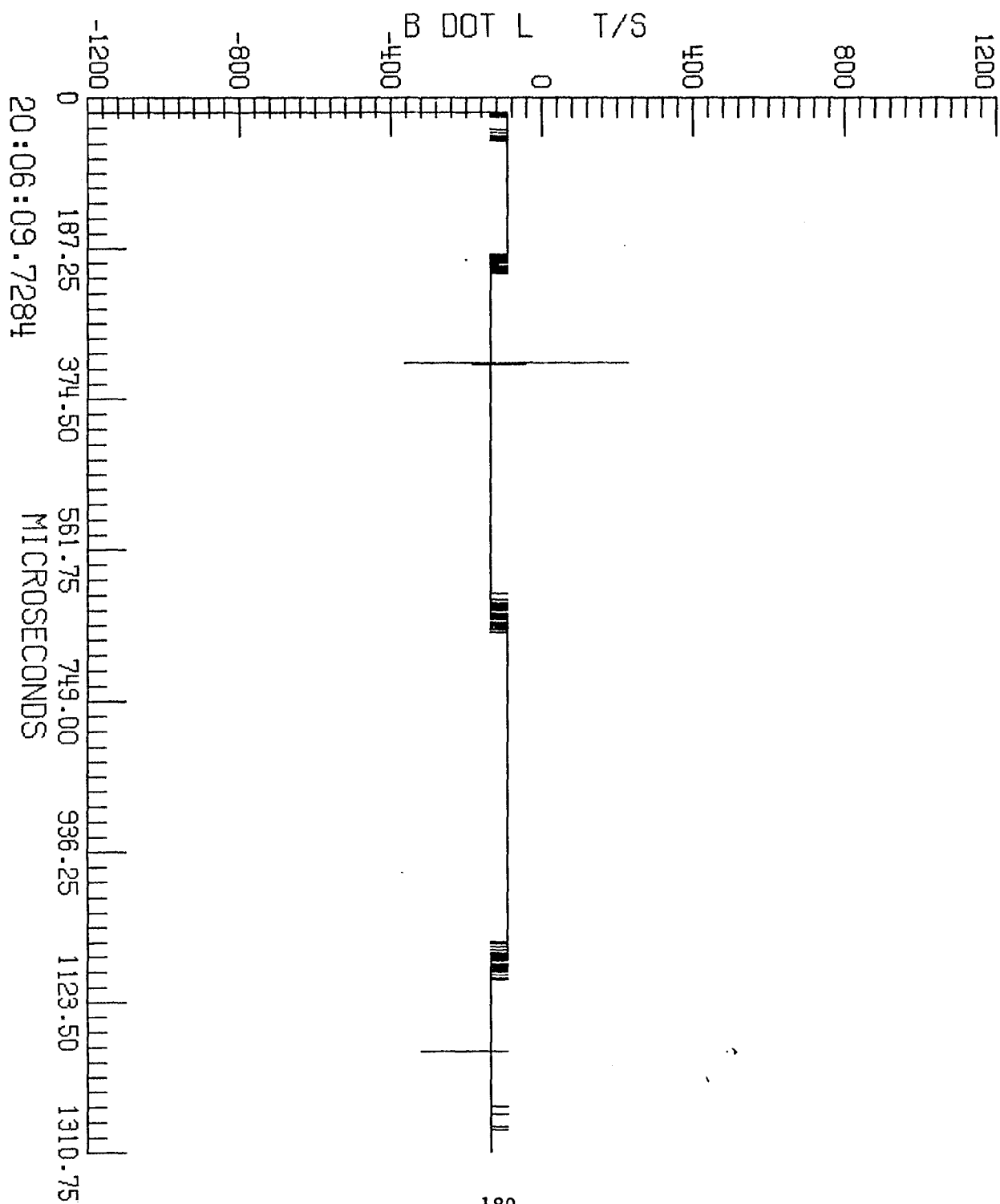
F106 LIGHTNING/TK 8/M. THOMAS
RUN NO. 1 S-001

TEST NO. 83



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 1 S-001

TEST NO. 83-

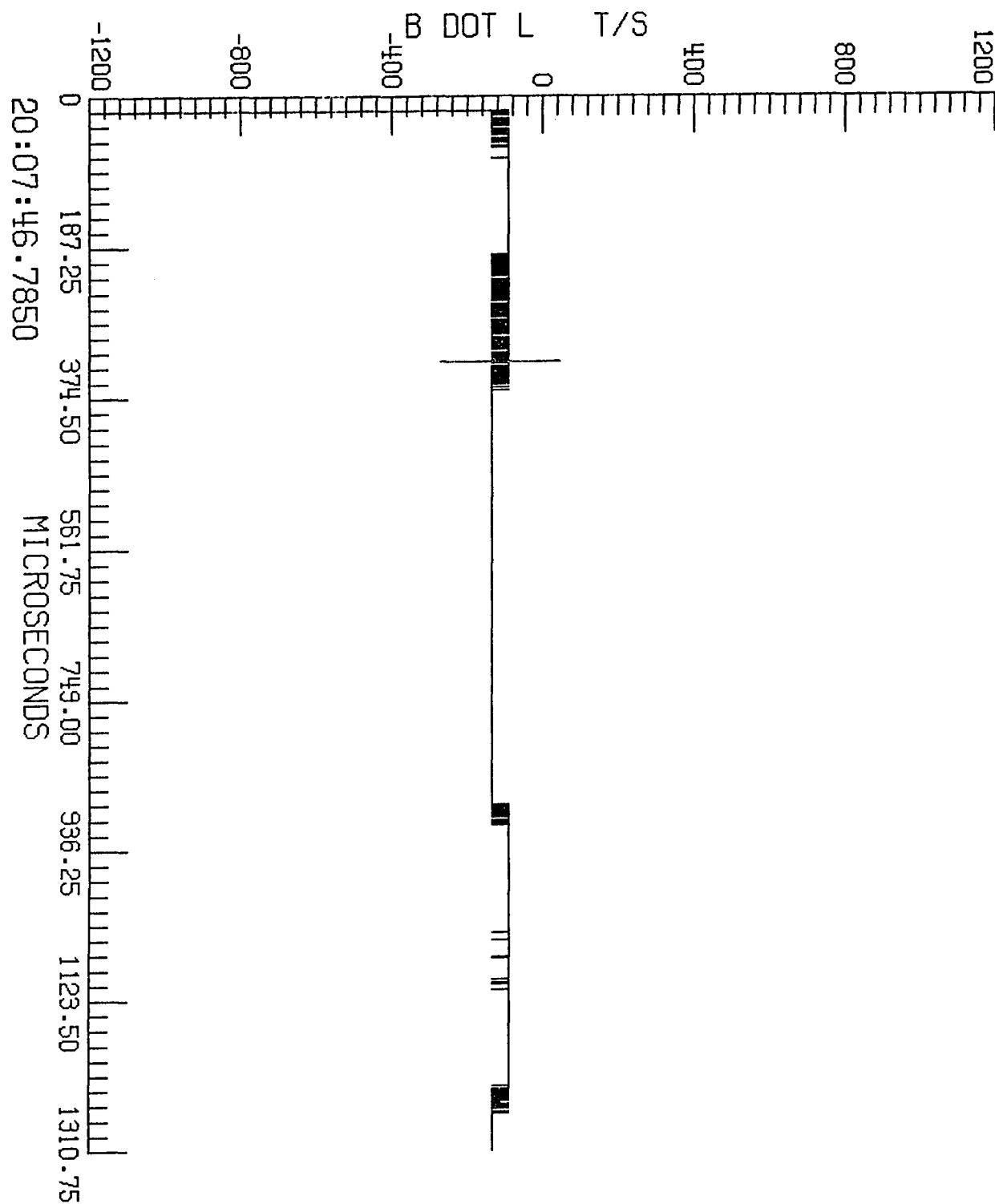


F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83-

RUN NO. 2

N-001

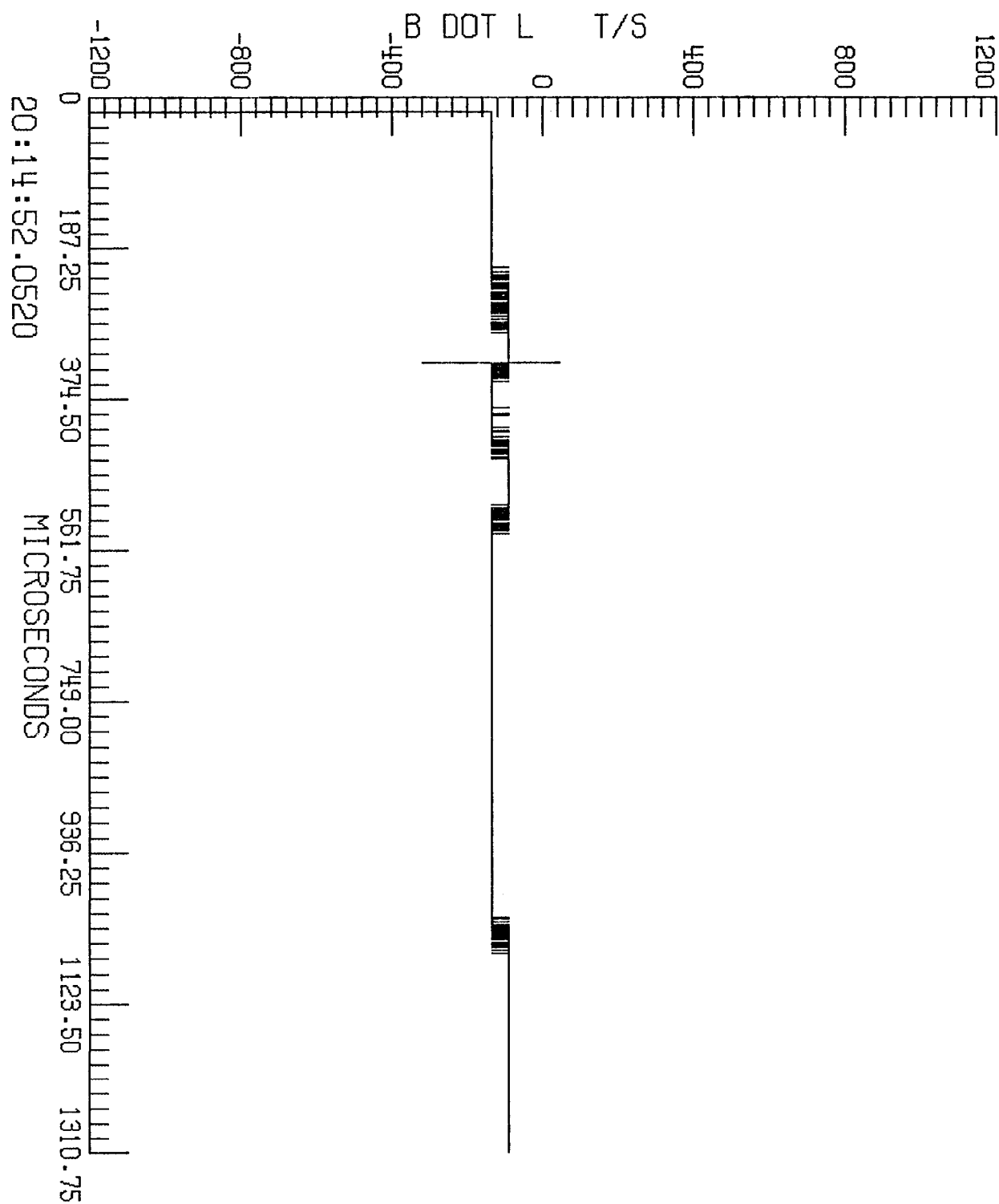


F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83-

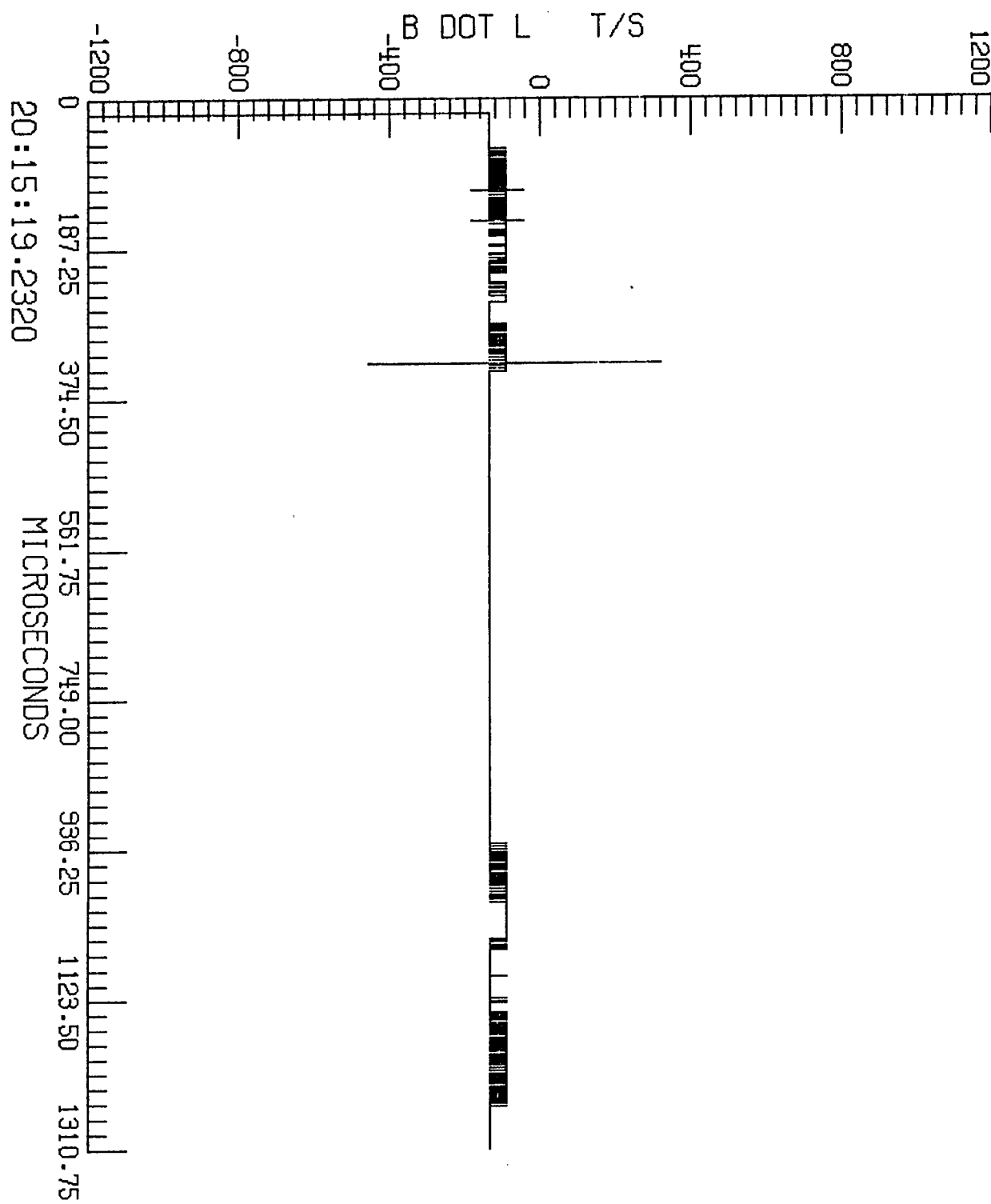
RUN NO. 3

N-002



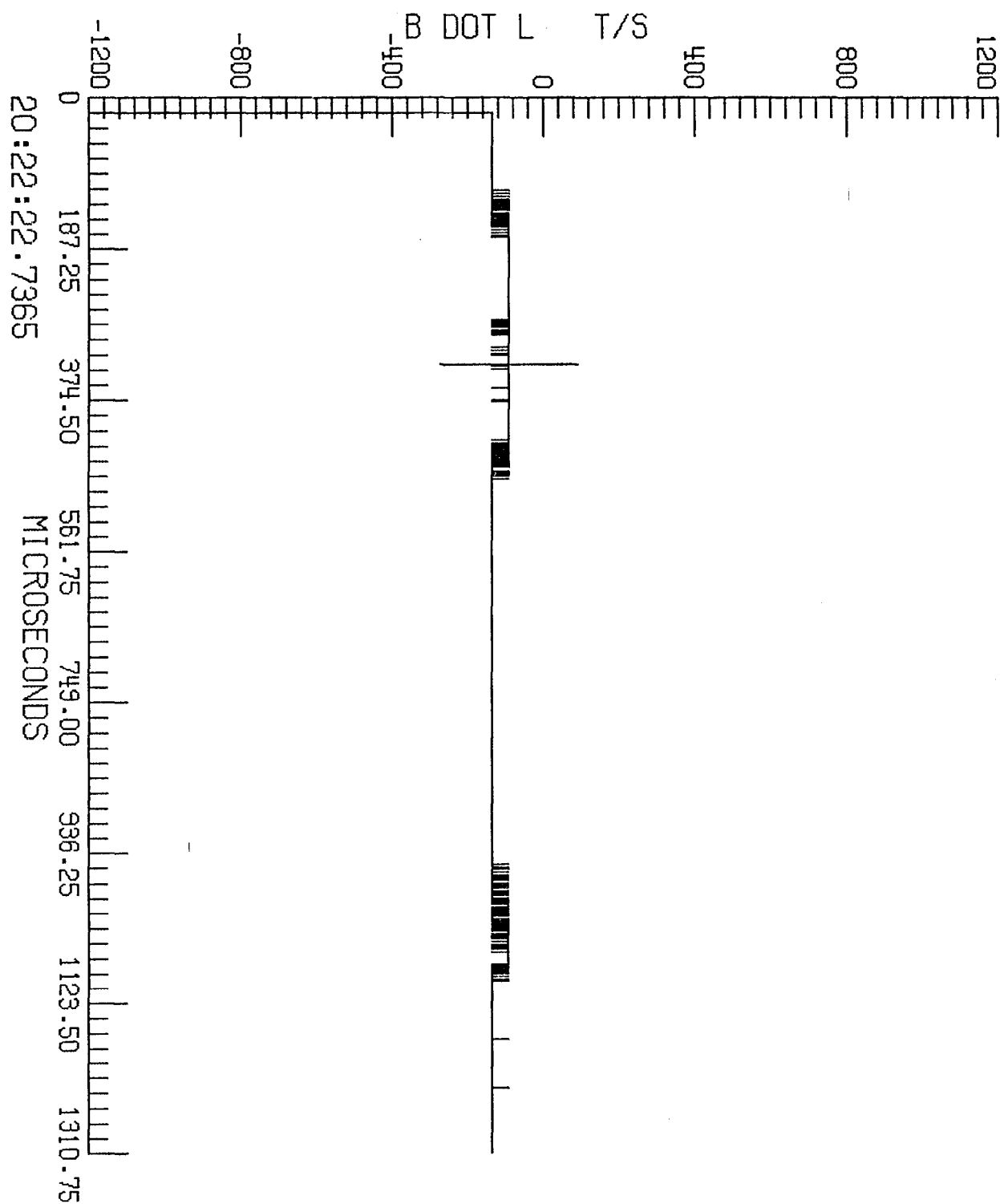
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 4 S-002

TEST NO. 83-



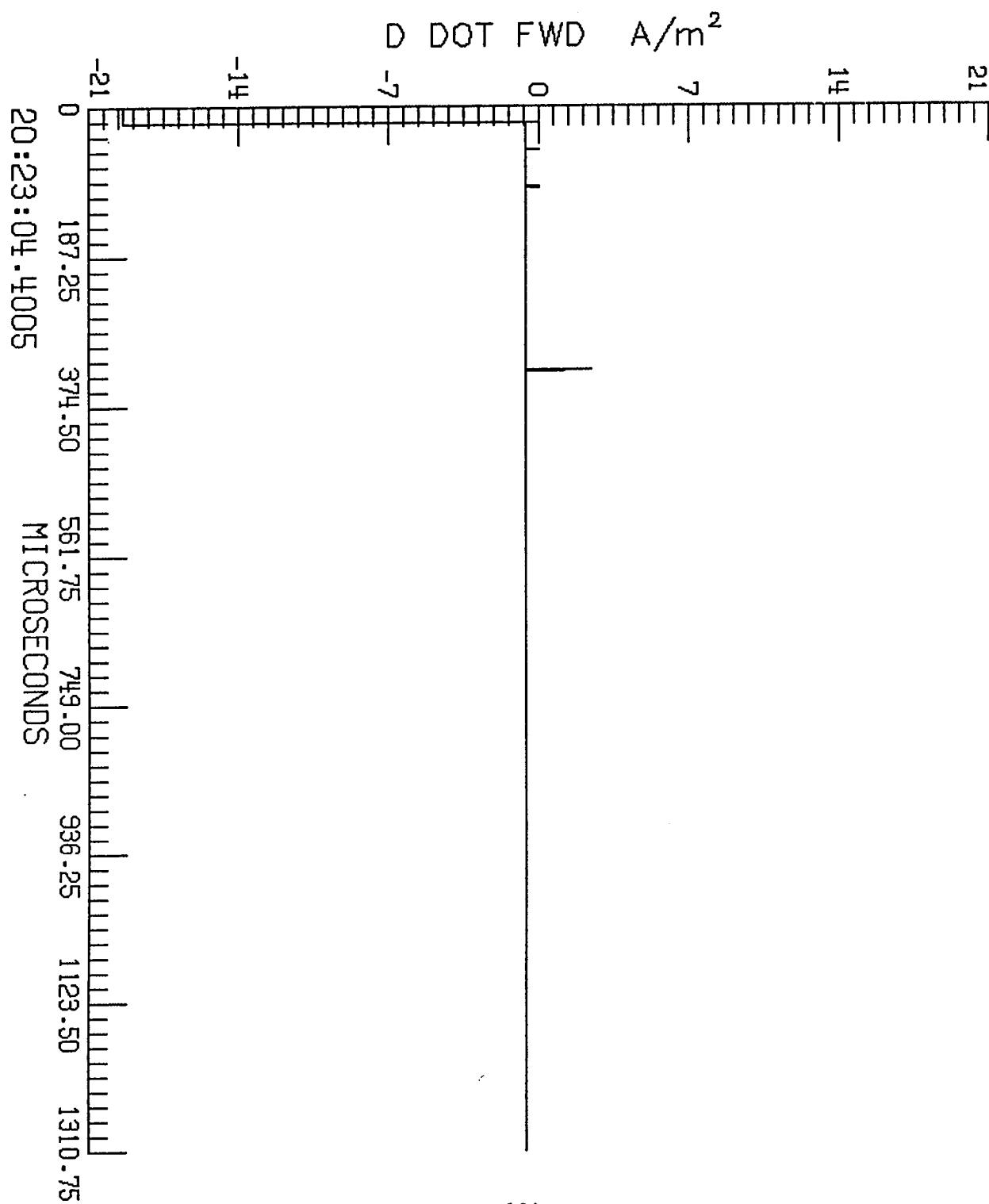
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 5 N-003

TEST NO. 83



F106 LIGHTNING/TK 8/M. THOMAS
RUN NO. 6 S-003

TEST NO. 83-

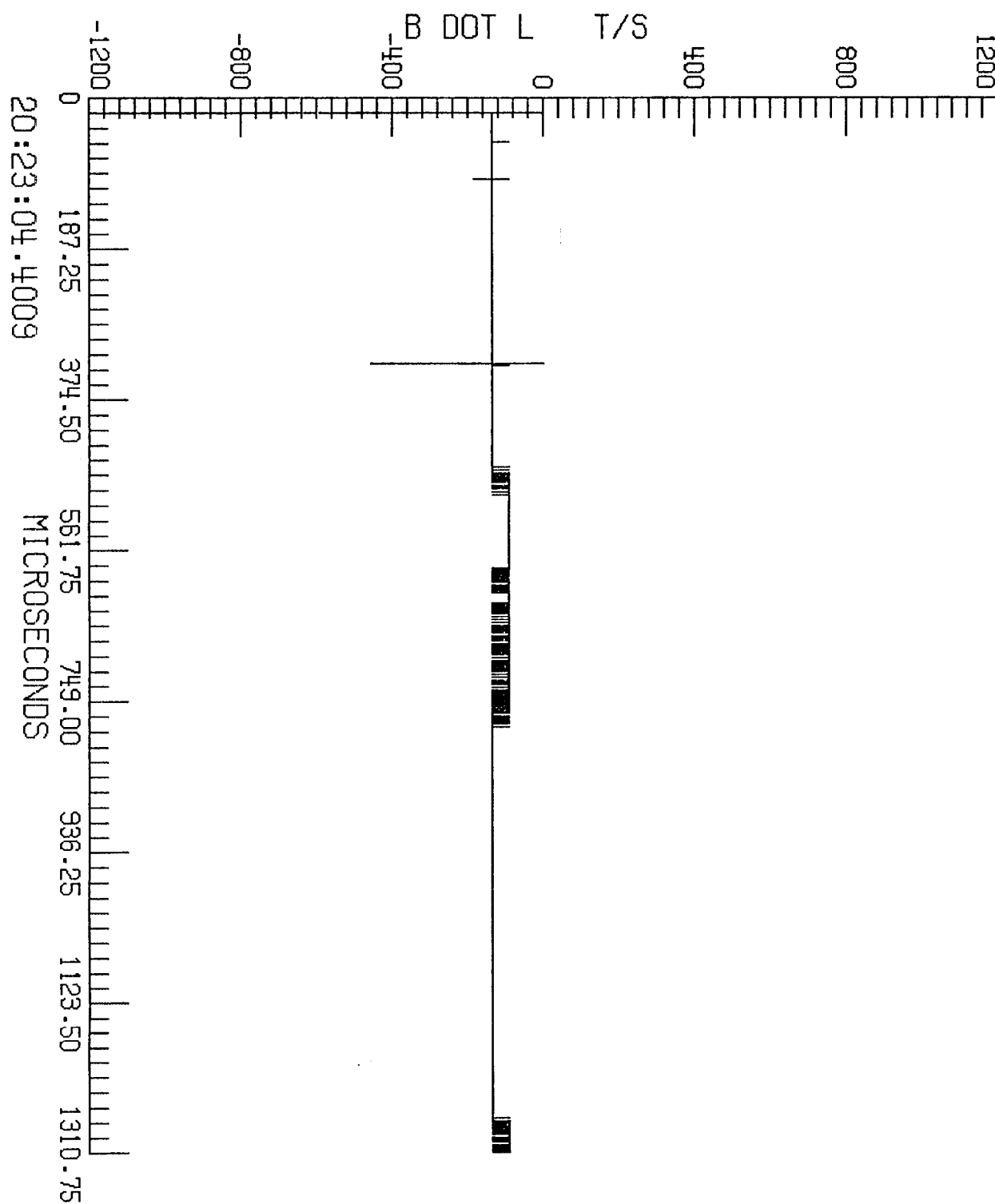


F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83-

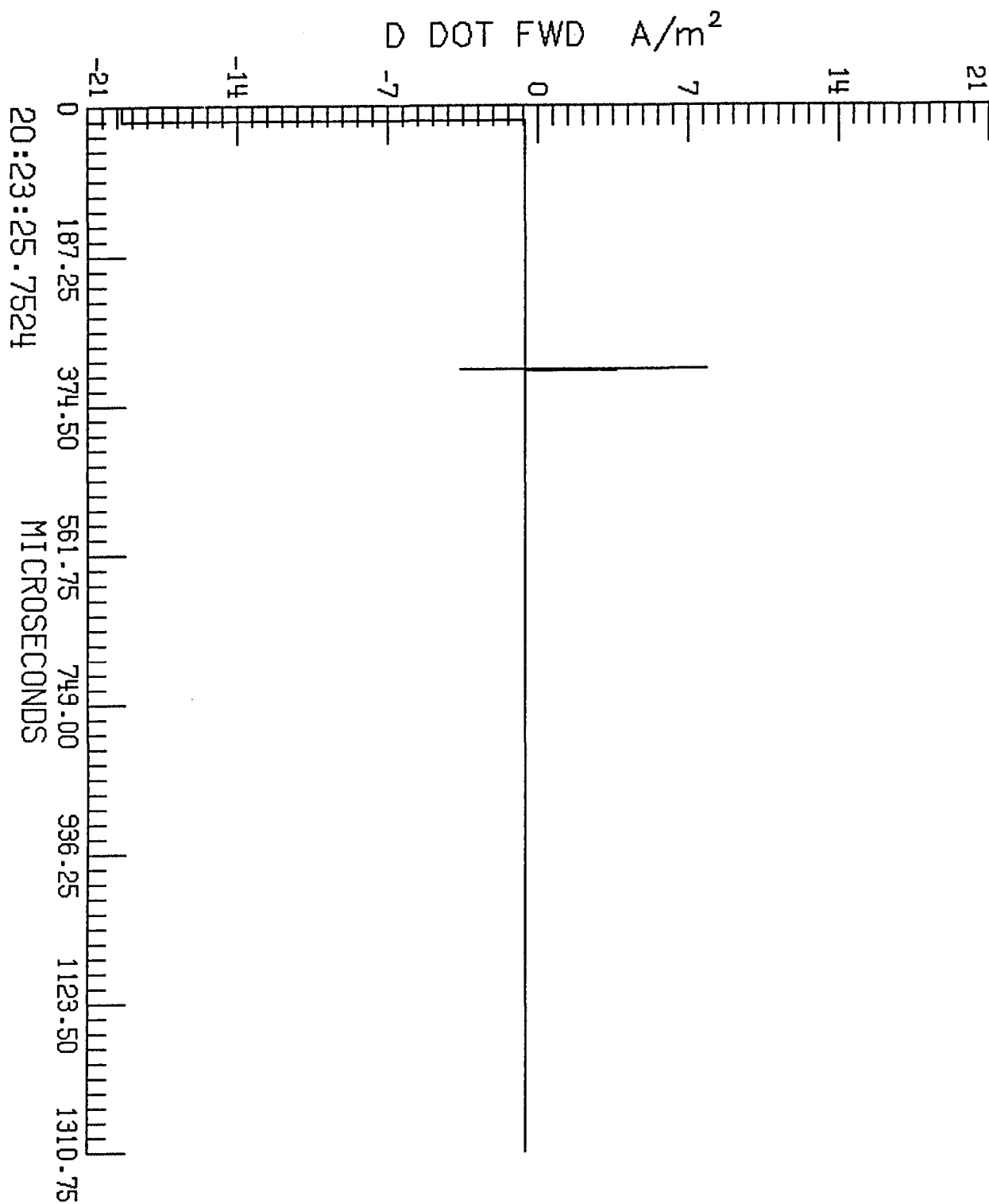
RUN NO. 6

S-003



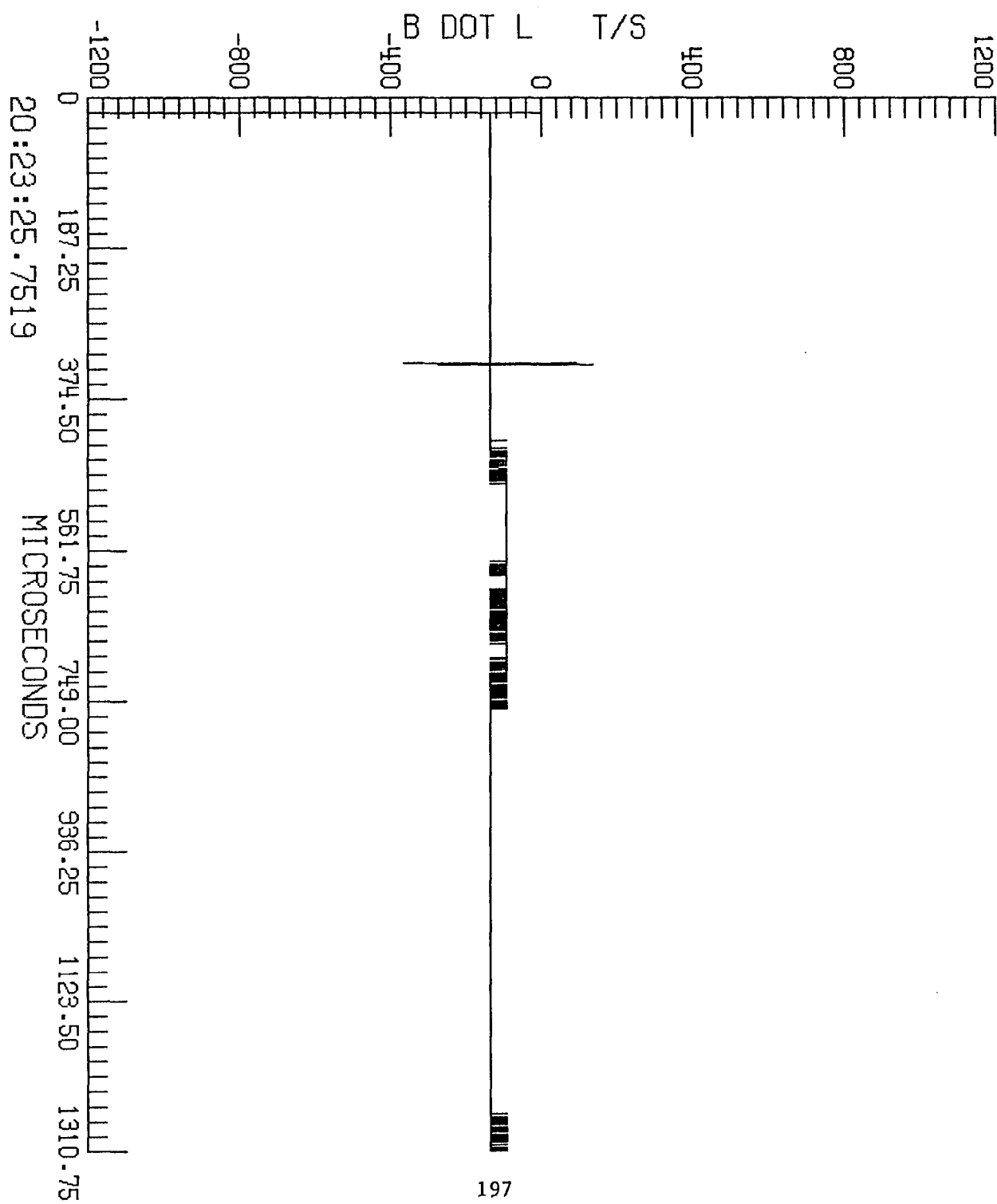
F106 LIGHTNING/TK 8/M. THOMAS
RUN NO. 7

TEST NO. 83.



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 7 S-004

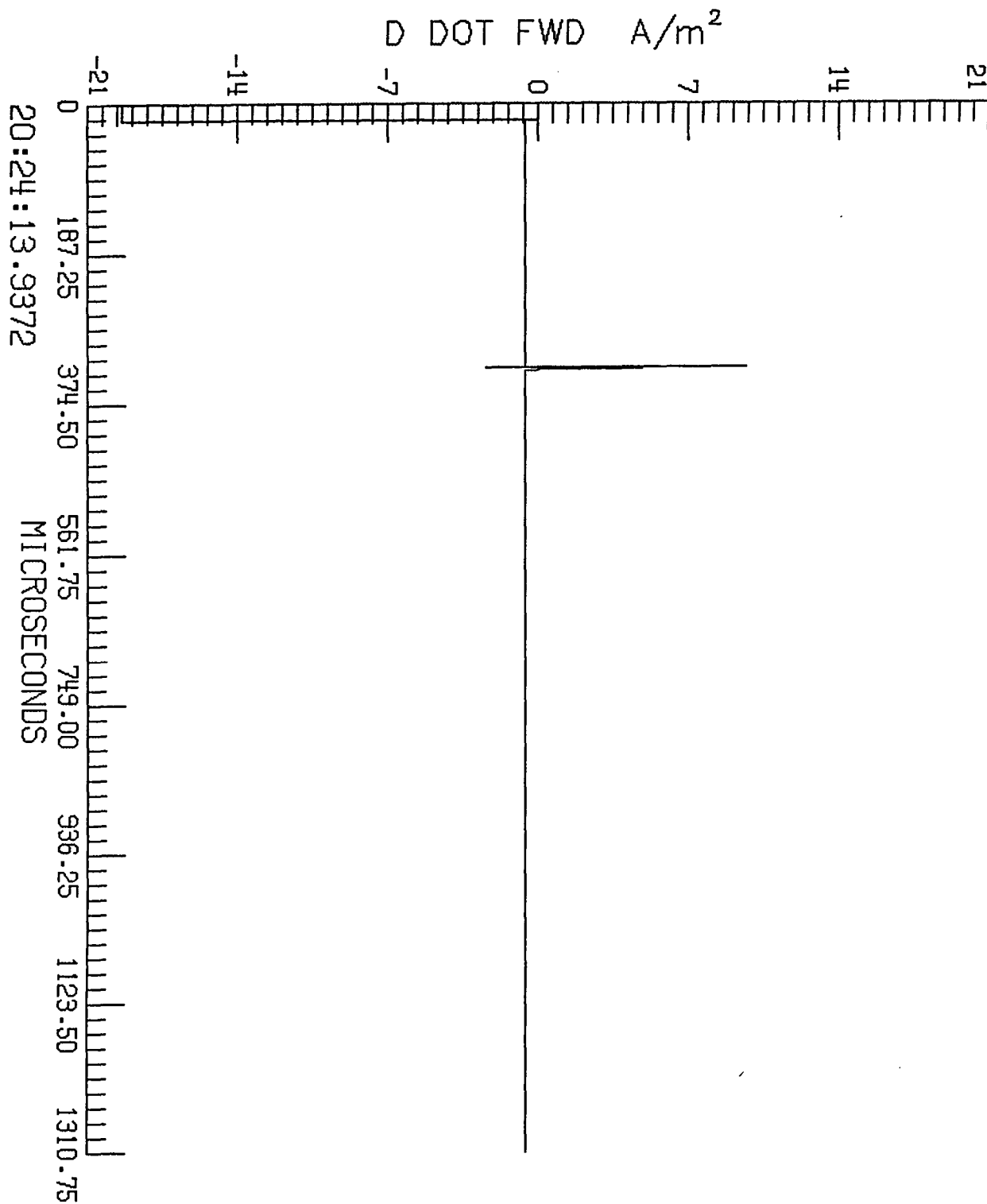
TEST NO. 83-



F106 LIGHTNING/TK 8/M. THOMAS
RUN NO. 8

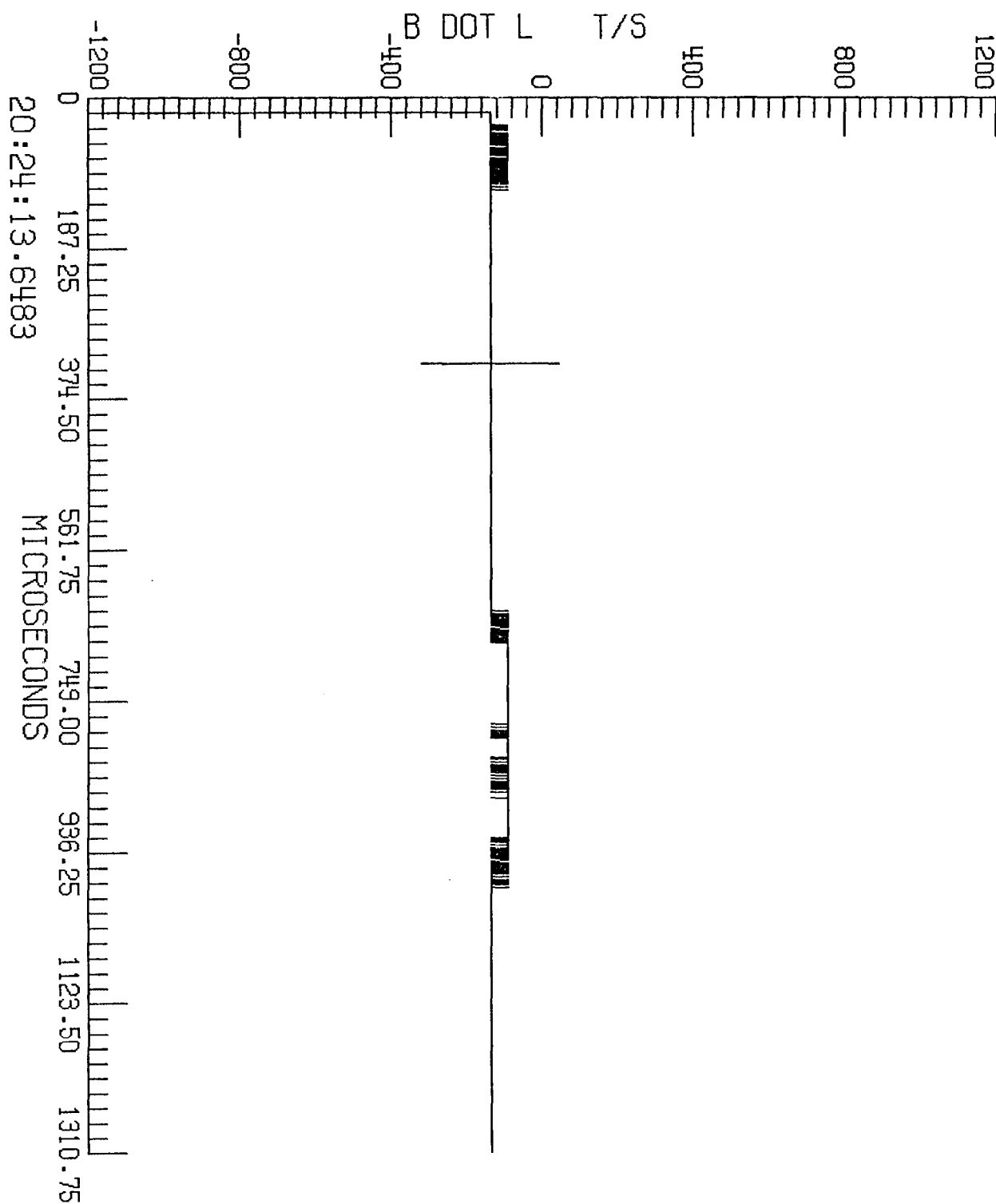
TEST NO. 83.

S-005



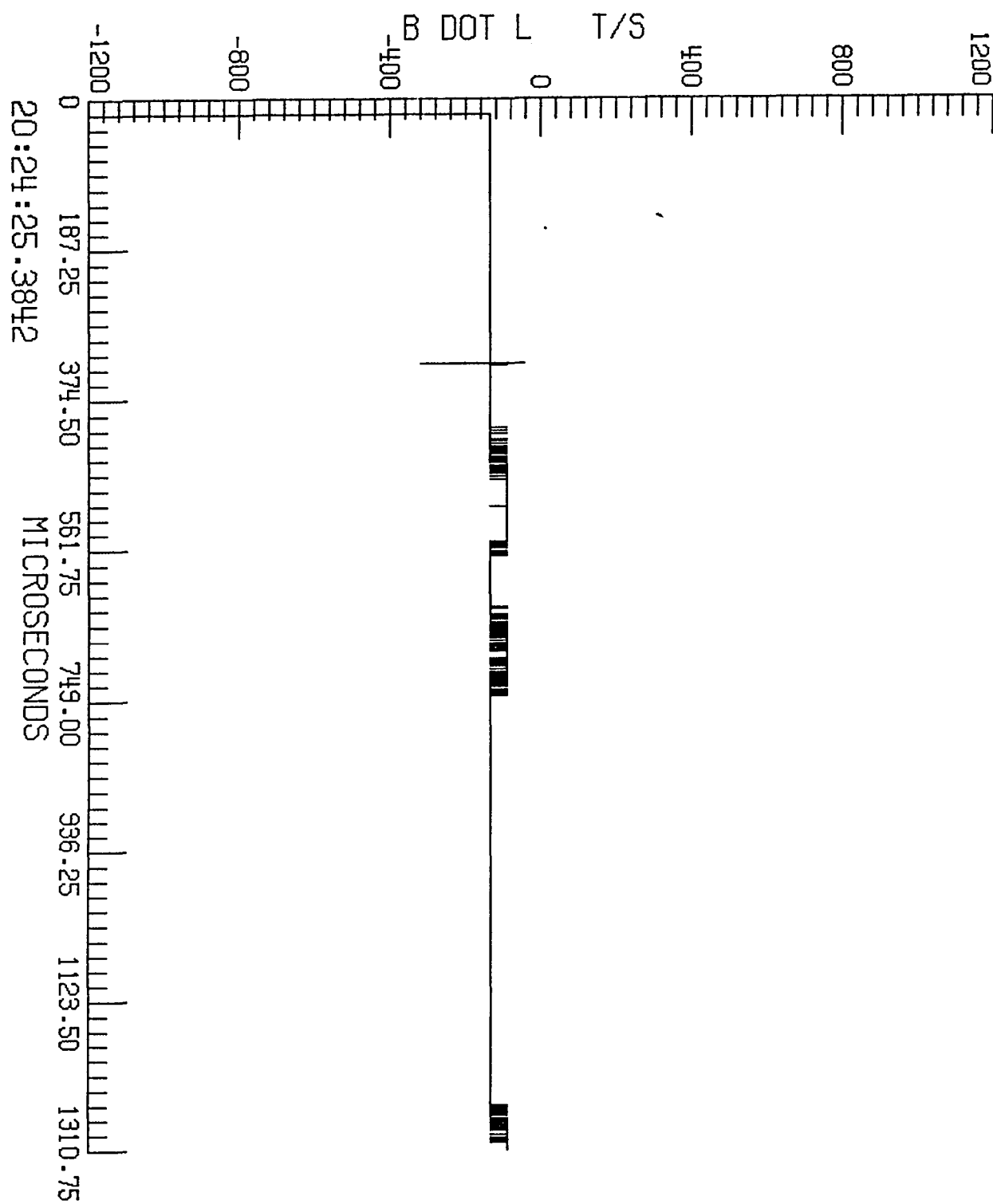
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 8 S-005

TEST NO. 83-



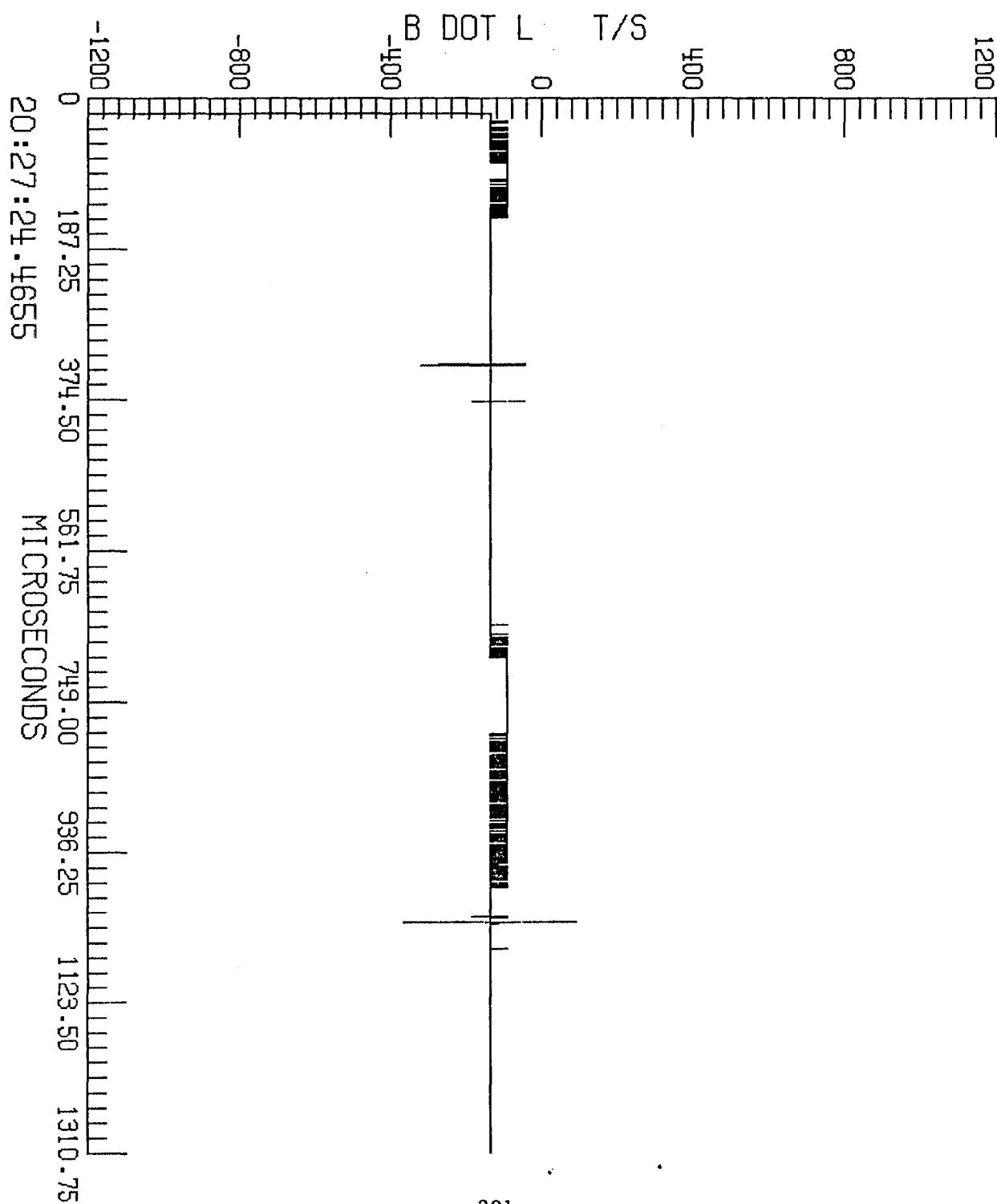
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 9 S-006

TEST NO. 83-



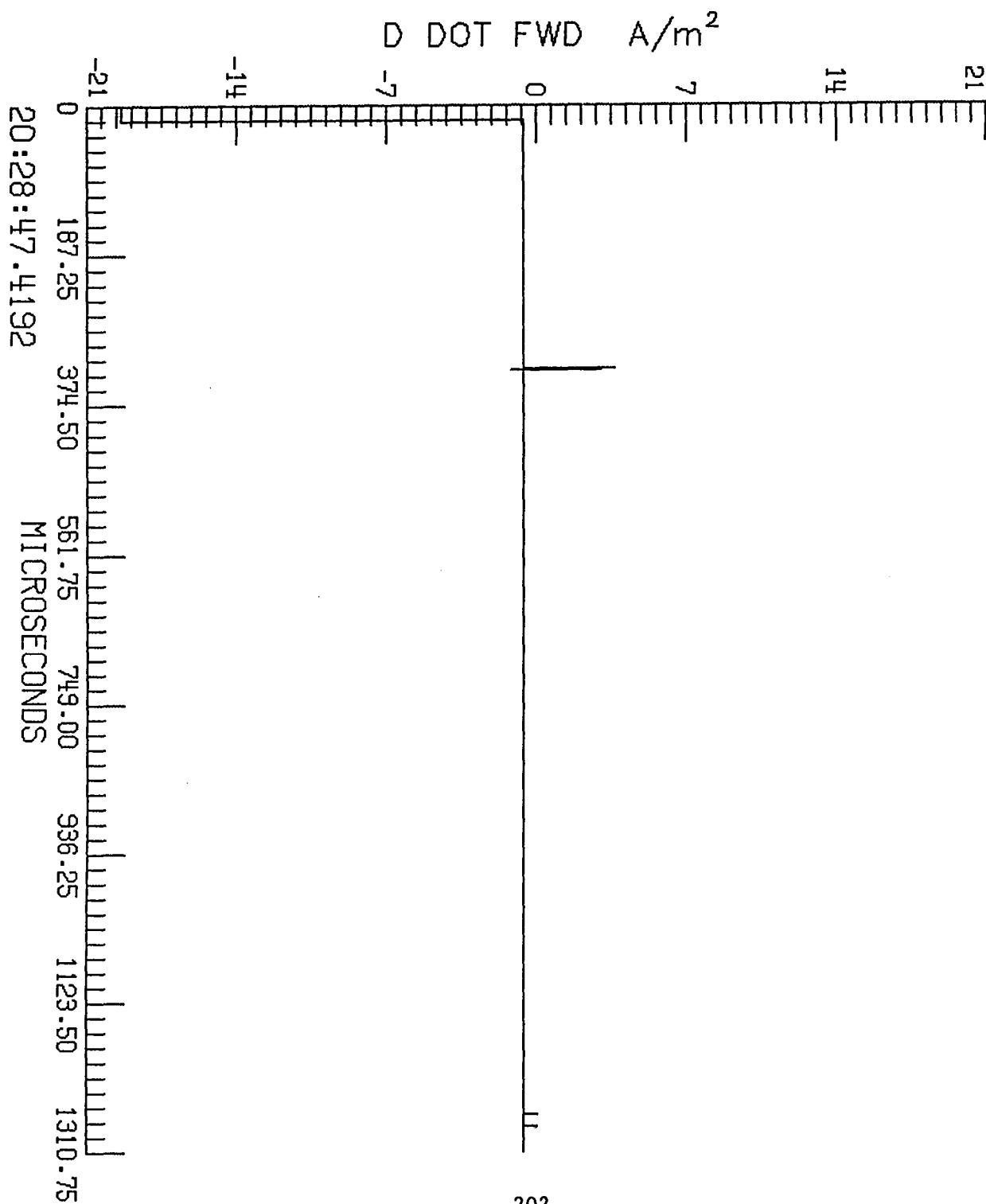
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 10 N-004

TEST NO. 83-



F106 LIGHTNING/TK 8/M. THOMAS
RUN NO. 11 S-007

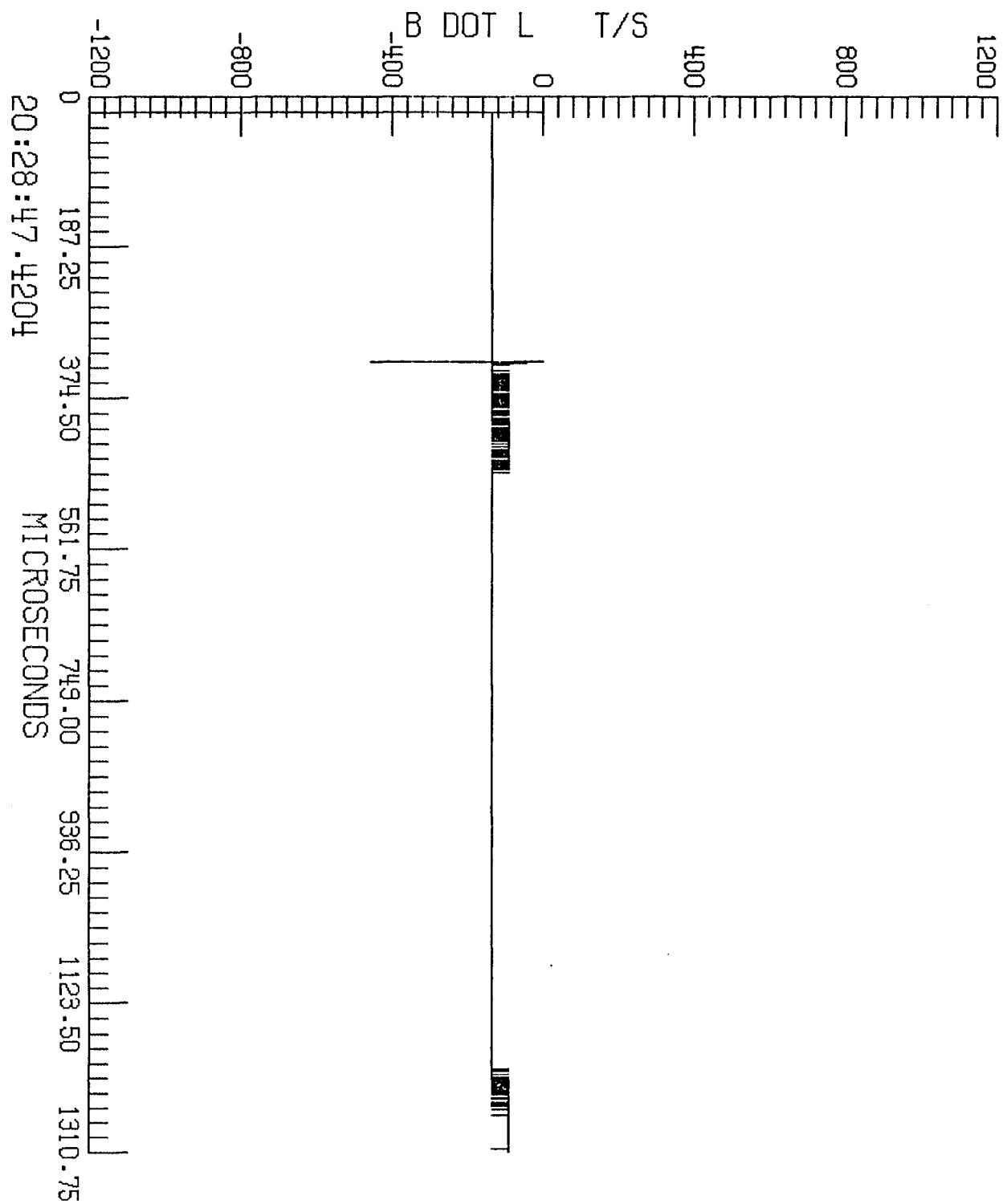
TEST NO. 83.



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 11

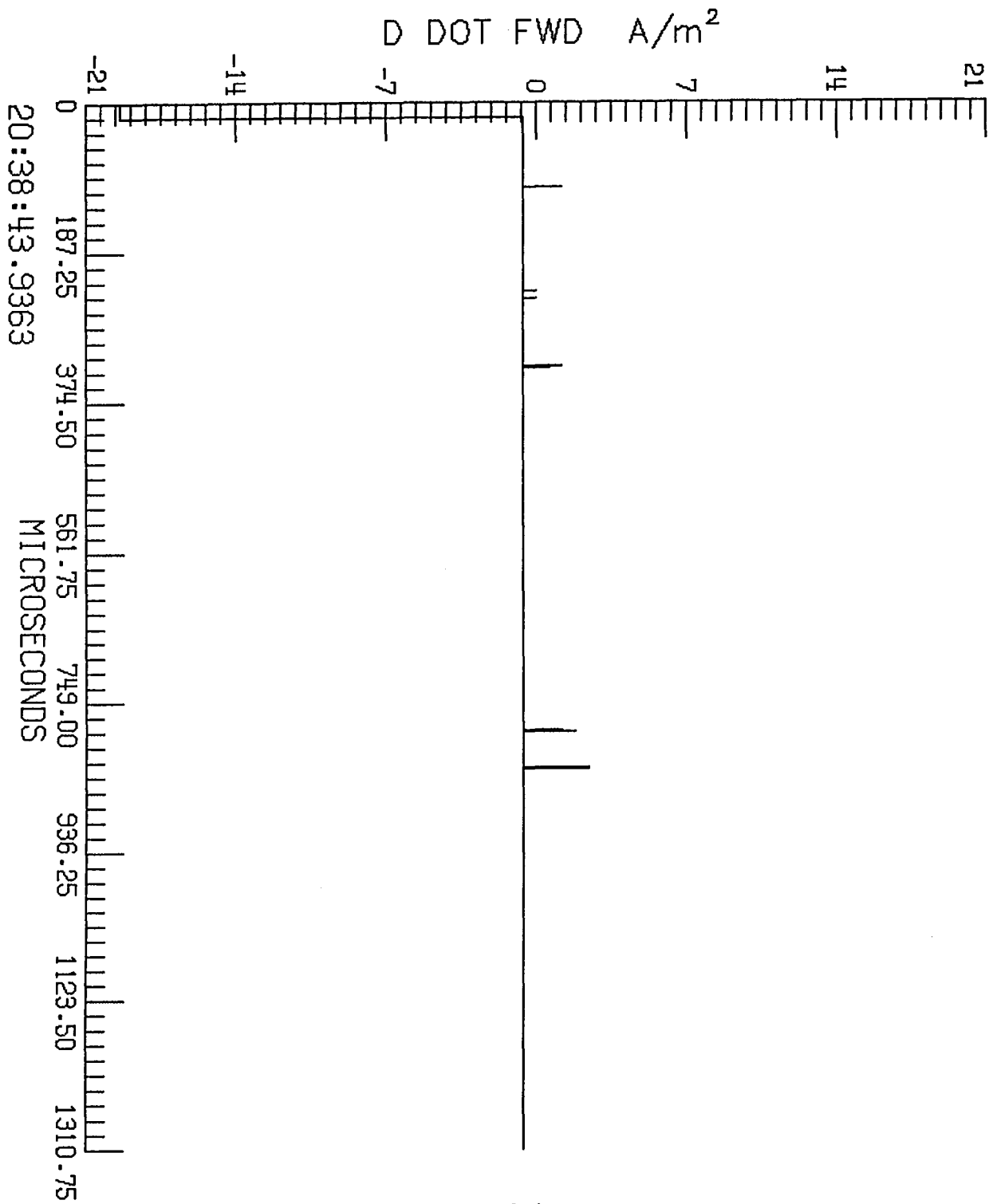
S-007

TEST NO. 83-



F106 LIGHTNING/TK 8/M. THOMAS
RUN NO. 12 S-008

TEST NO. 83

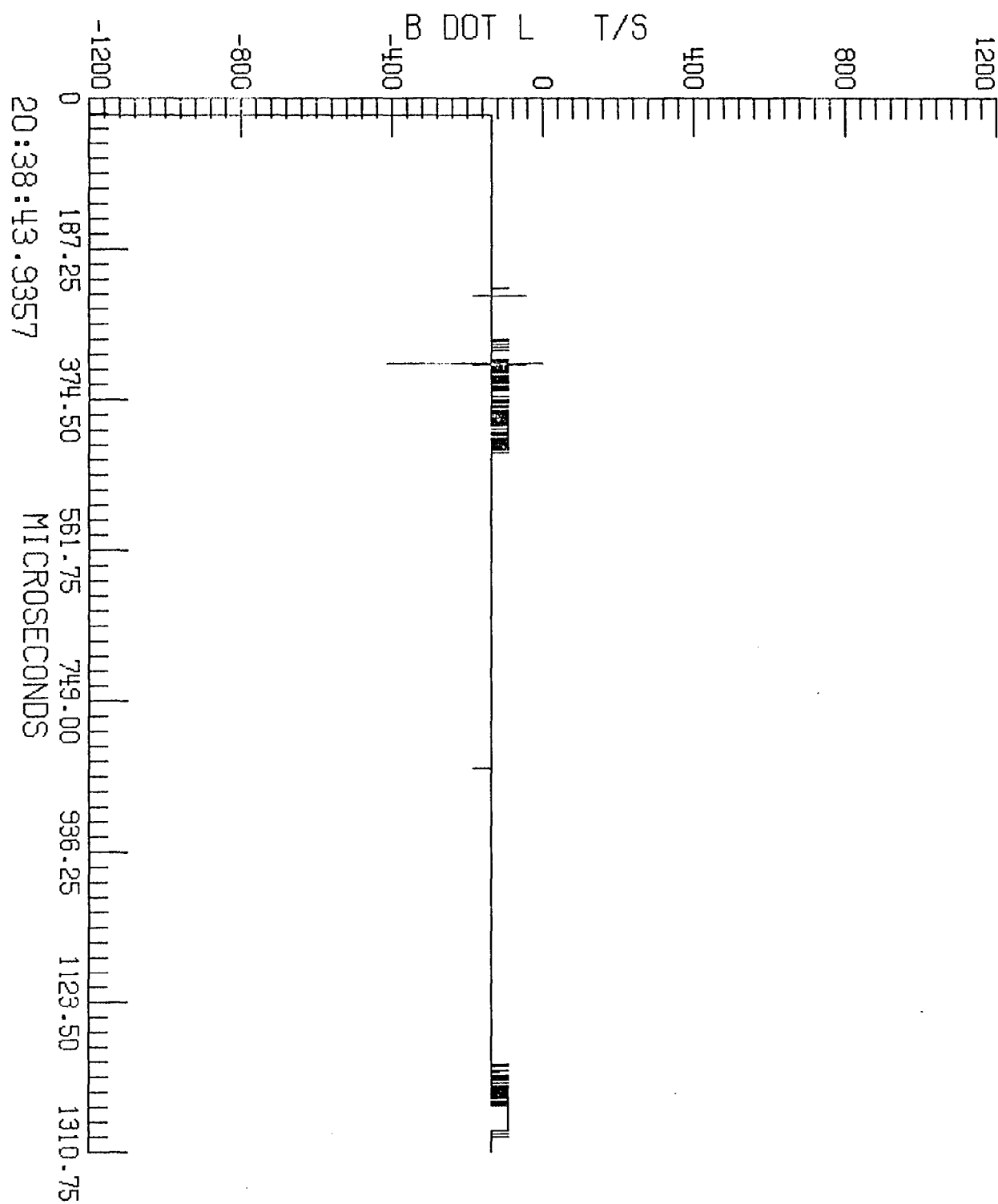


F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83

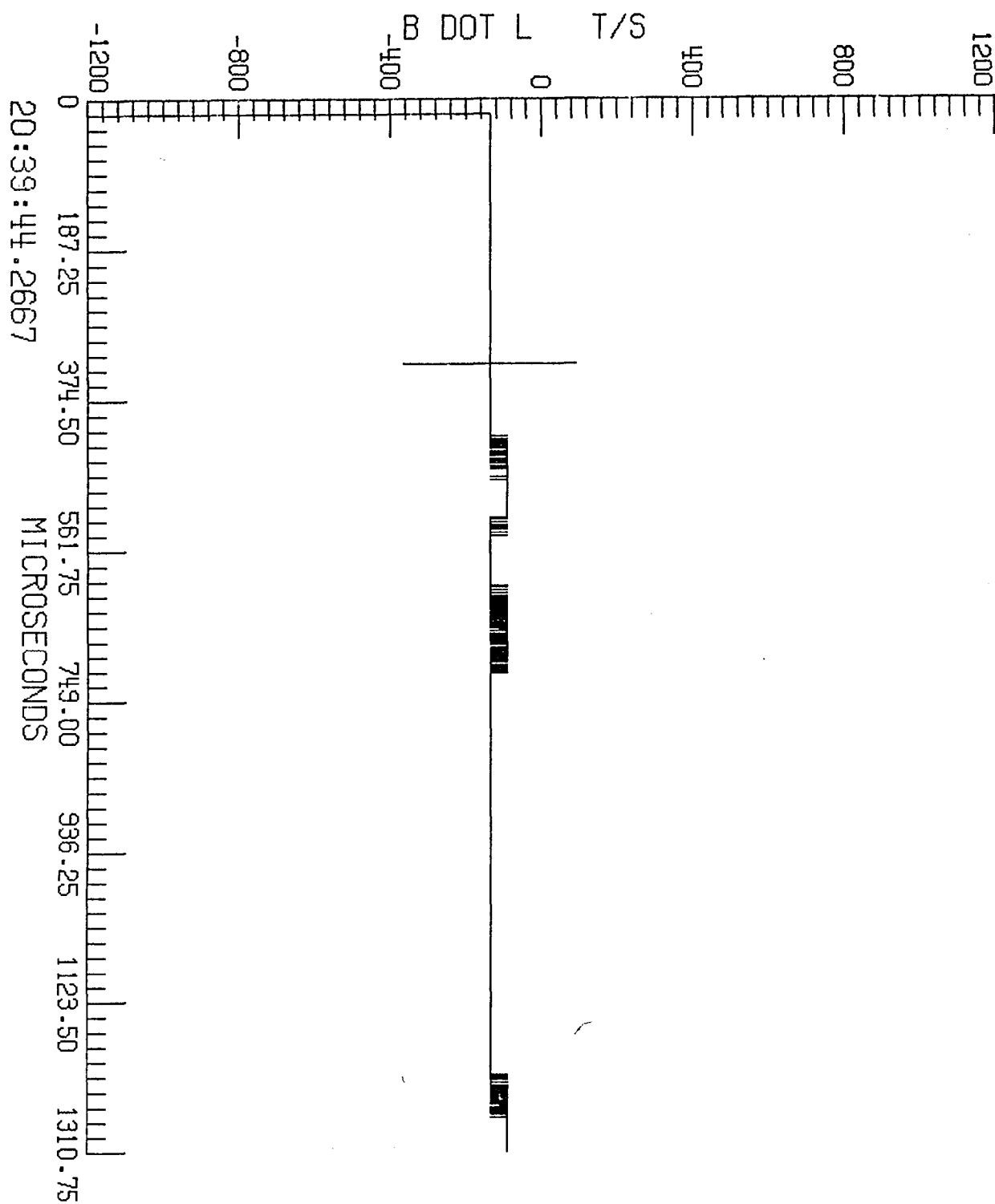
RUN NO. 12

S-008



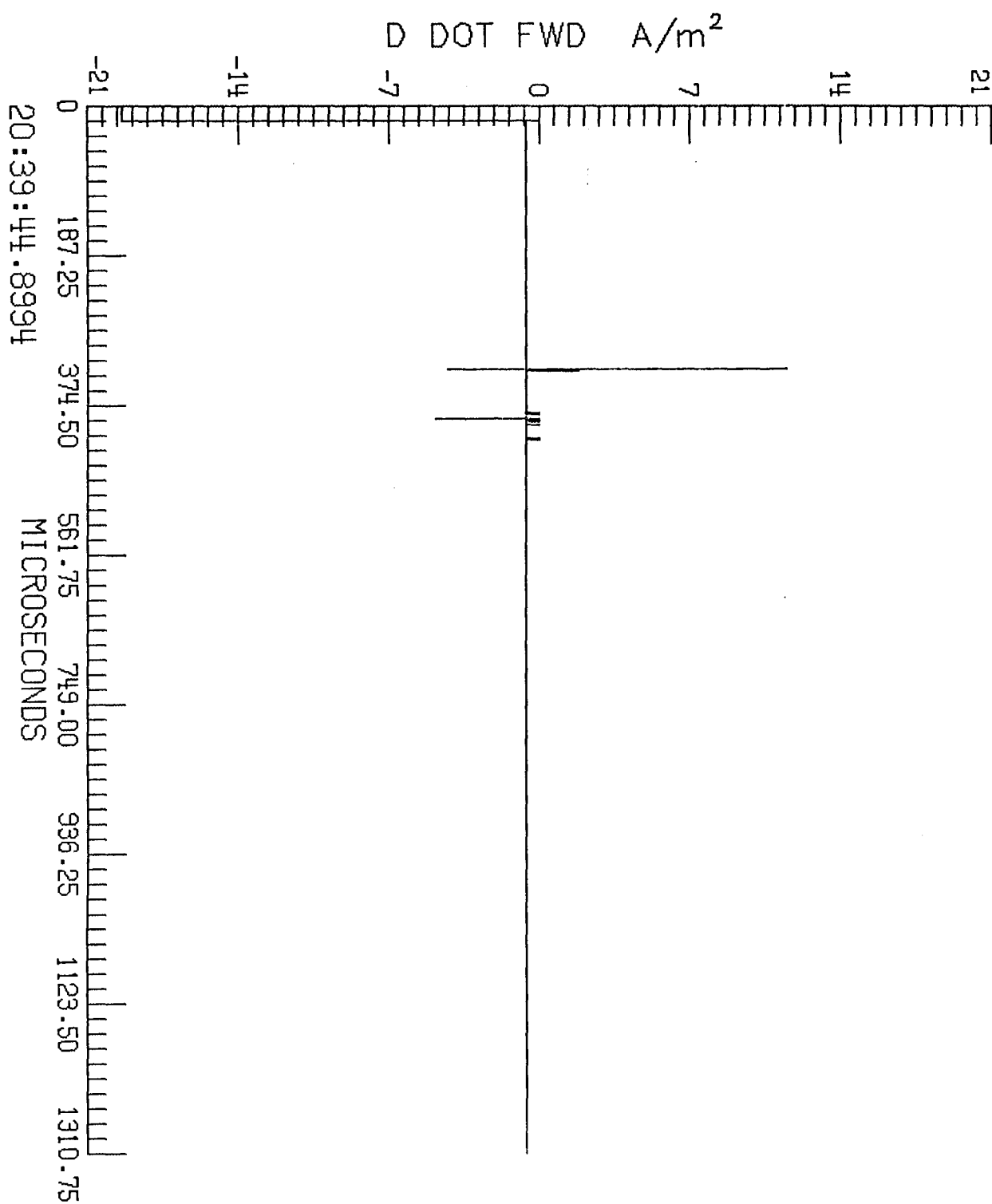
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 13 N-005

TEST NO. 83



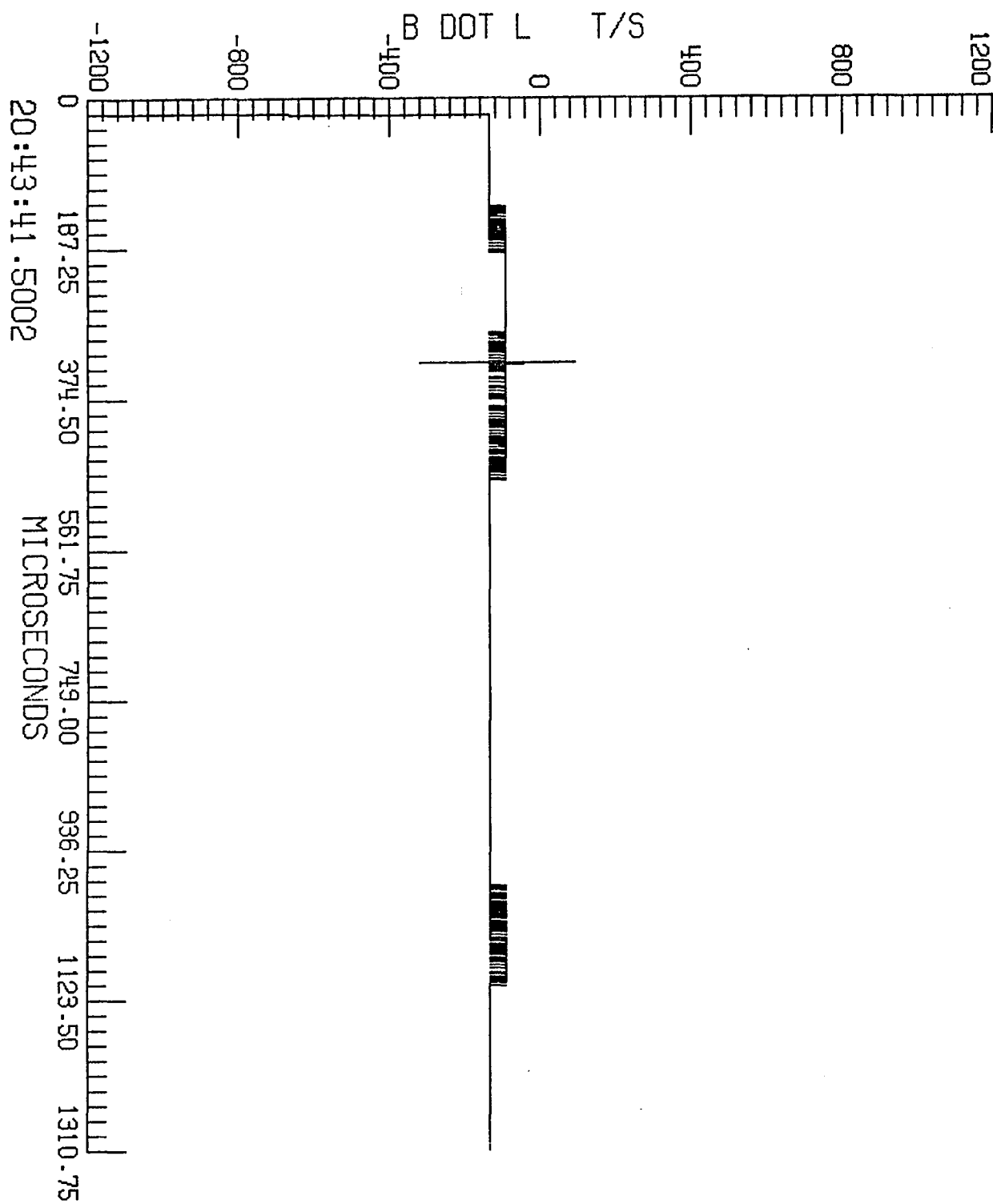
F106 LIGHTNING/TK 8/M. THOMAS
RUN NO. 13 S-011

TEST NO. 83



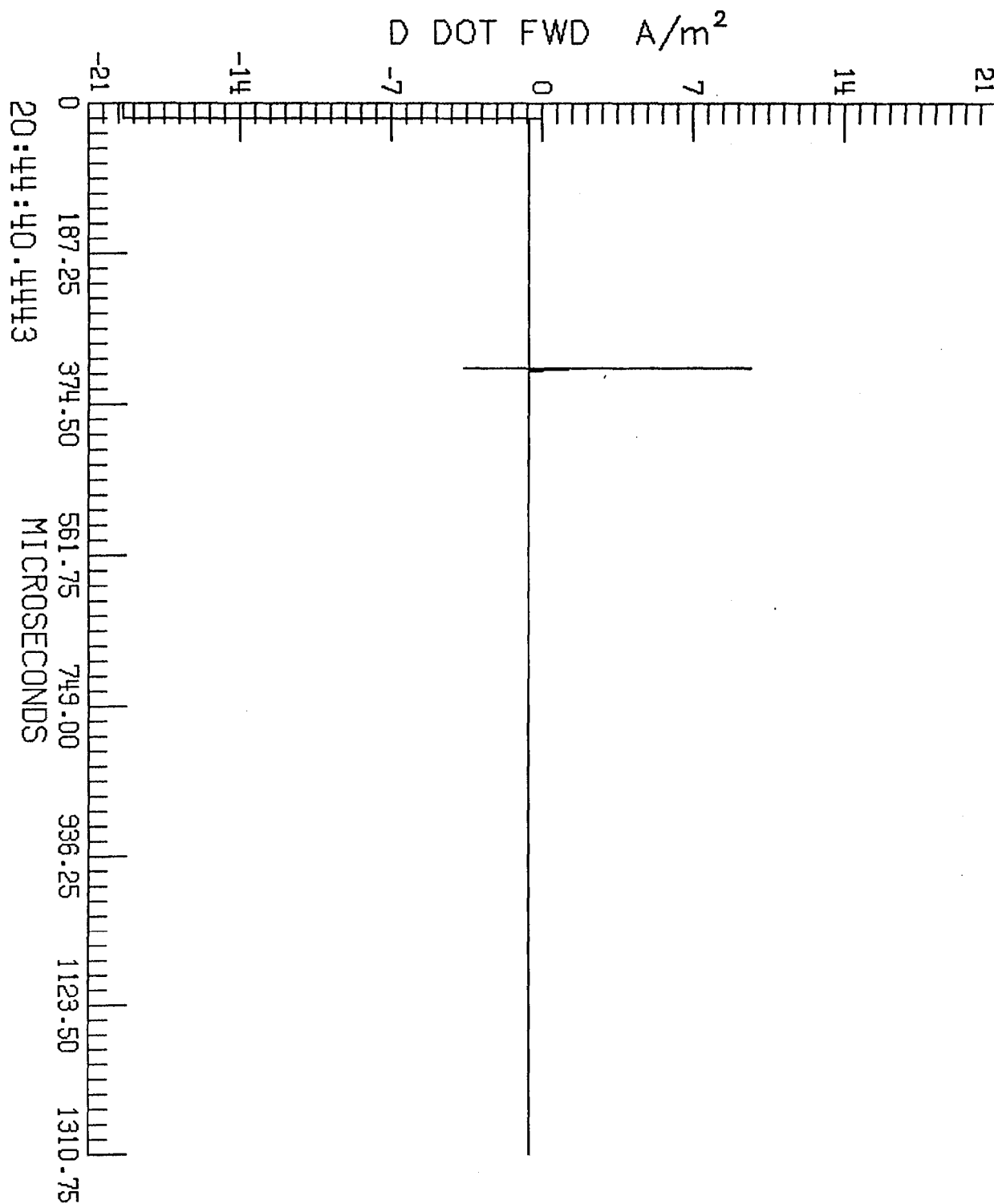
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 14

TEST NO. 83



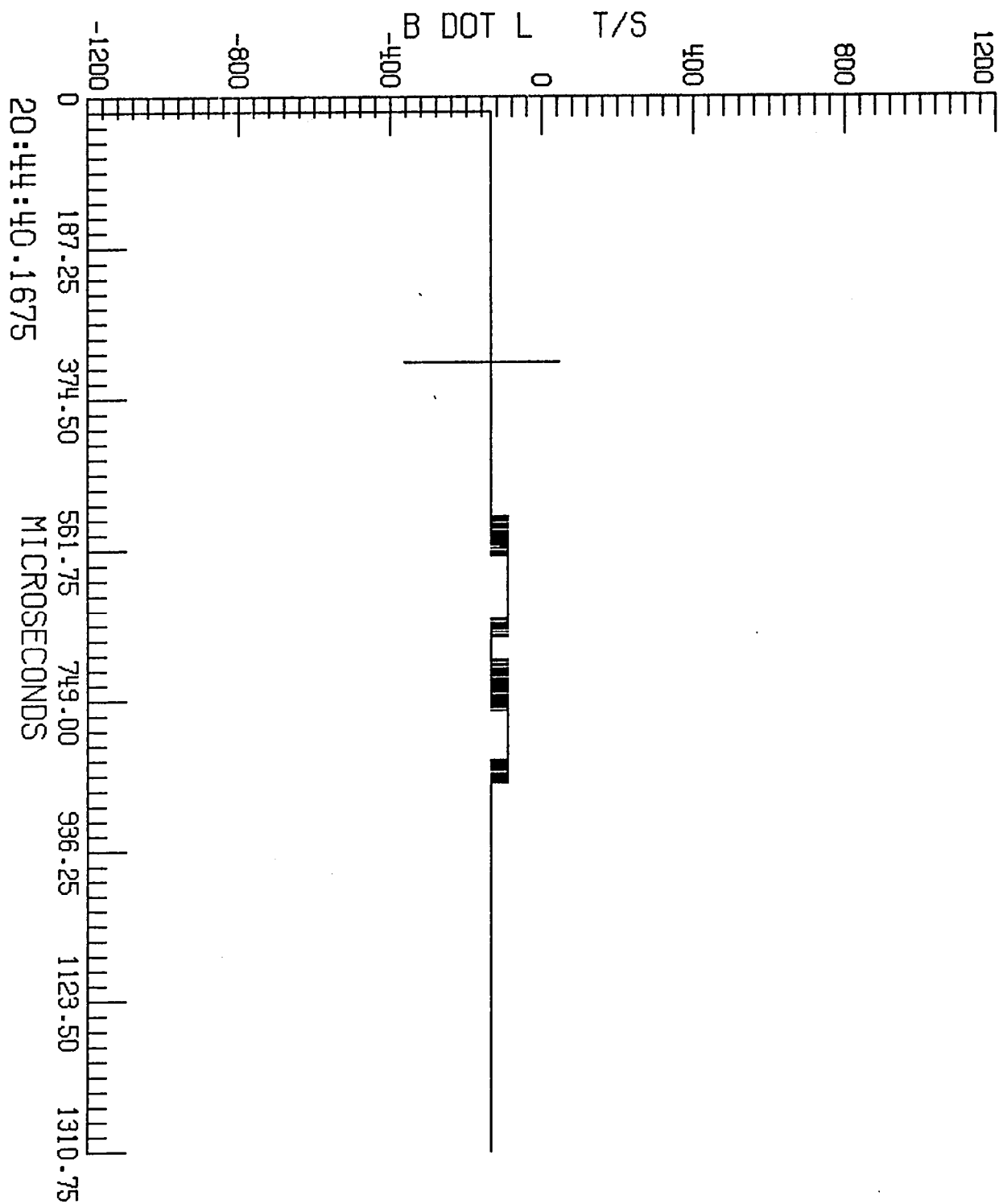
F106 LIGHTNING/TK 8/M. THOMAS
RUN NO. 15 N-007

TEST NO. 83



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 15 N-007

TEST NO. 83

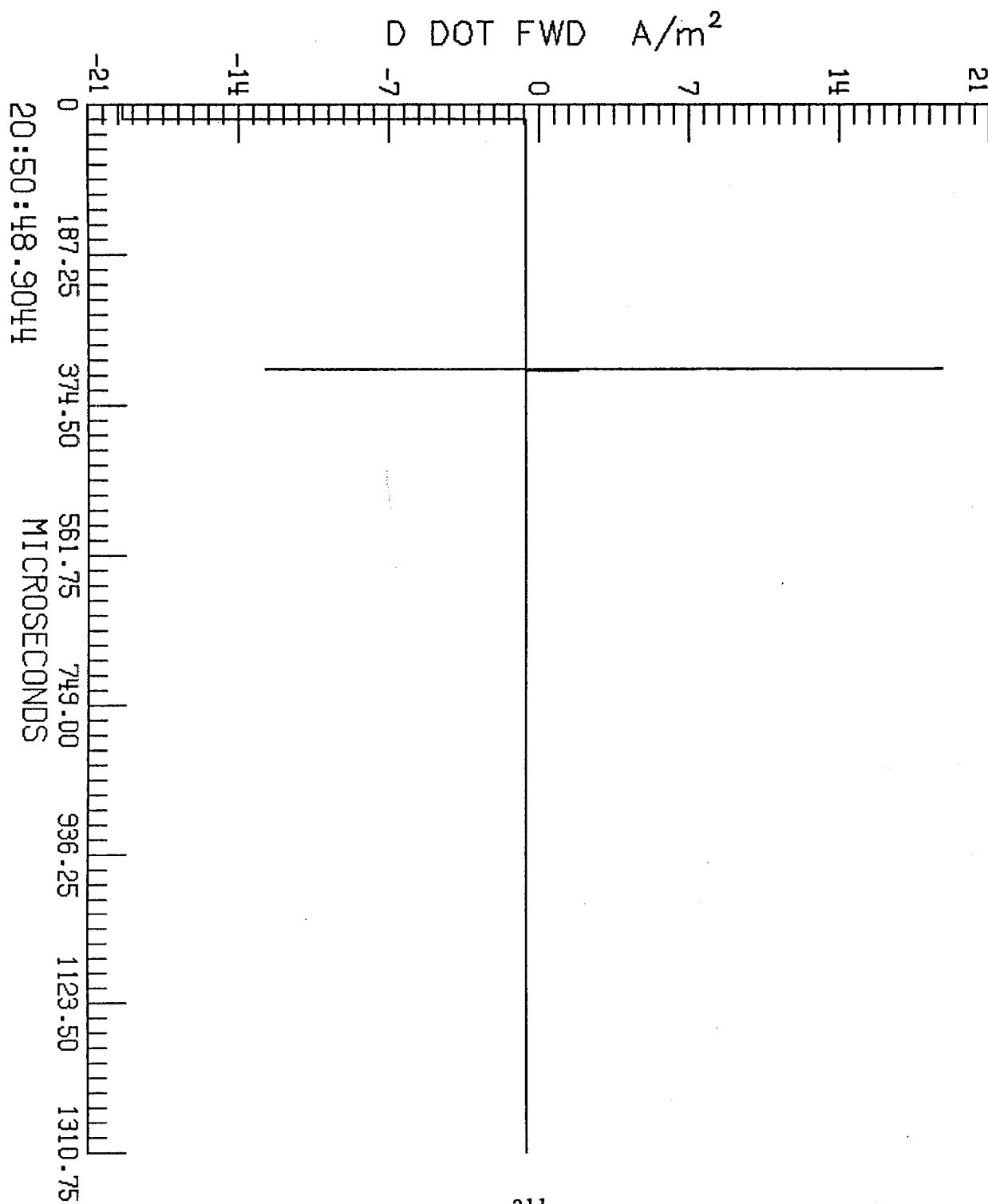


F106 LIGHTNING/TK 8/M. THOMAS

TEST NO. 83

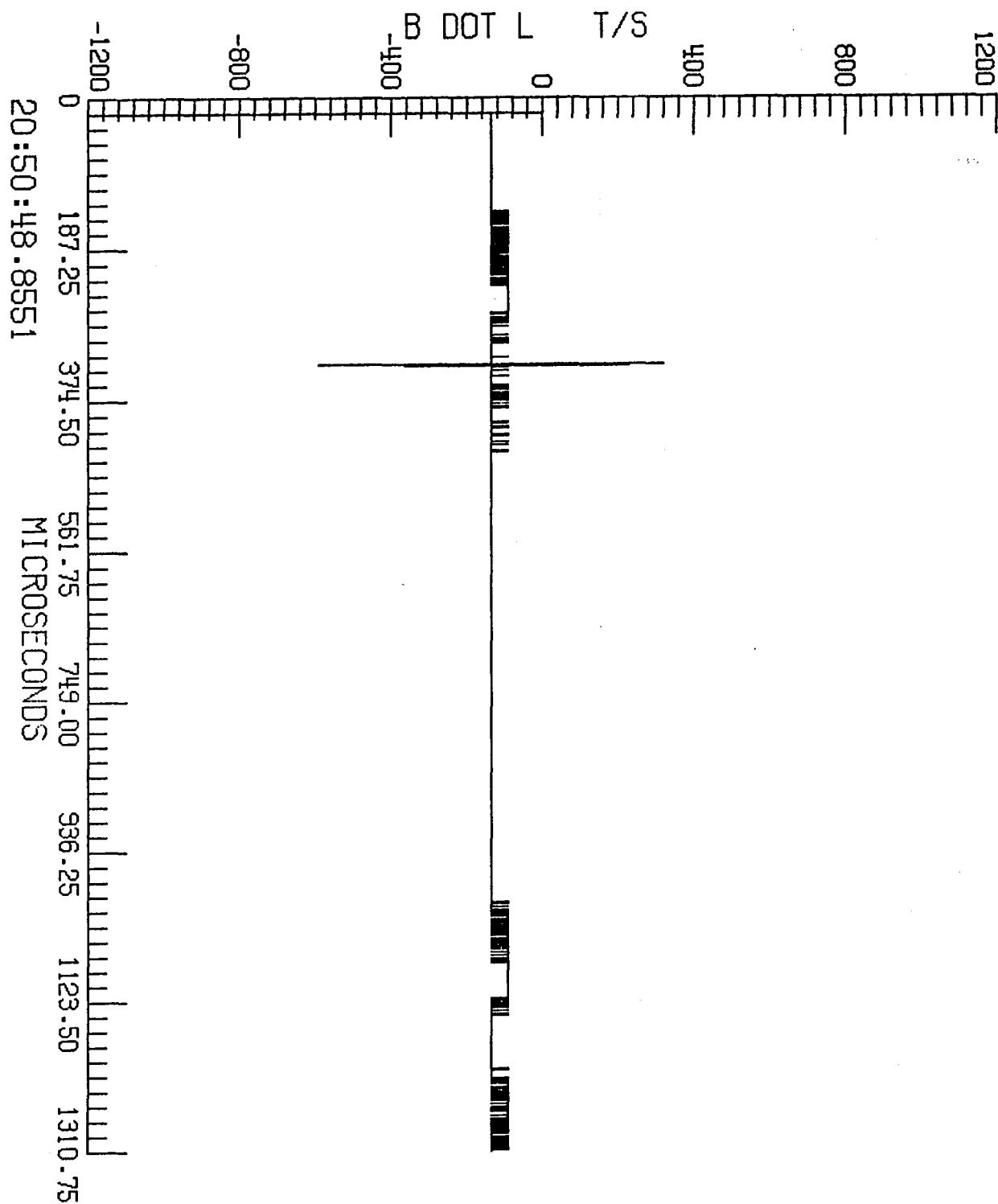
RUN NO. 16

S-012



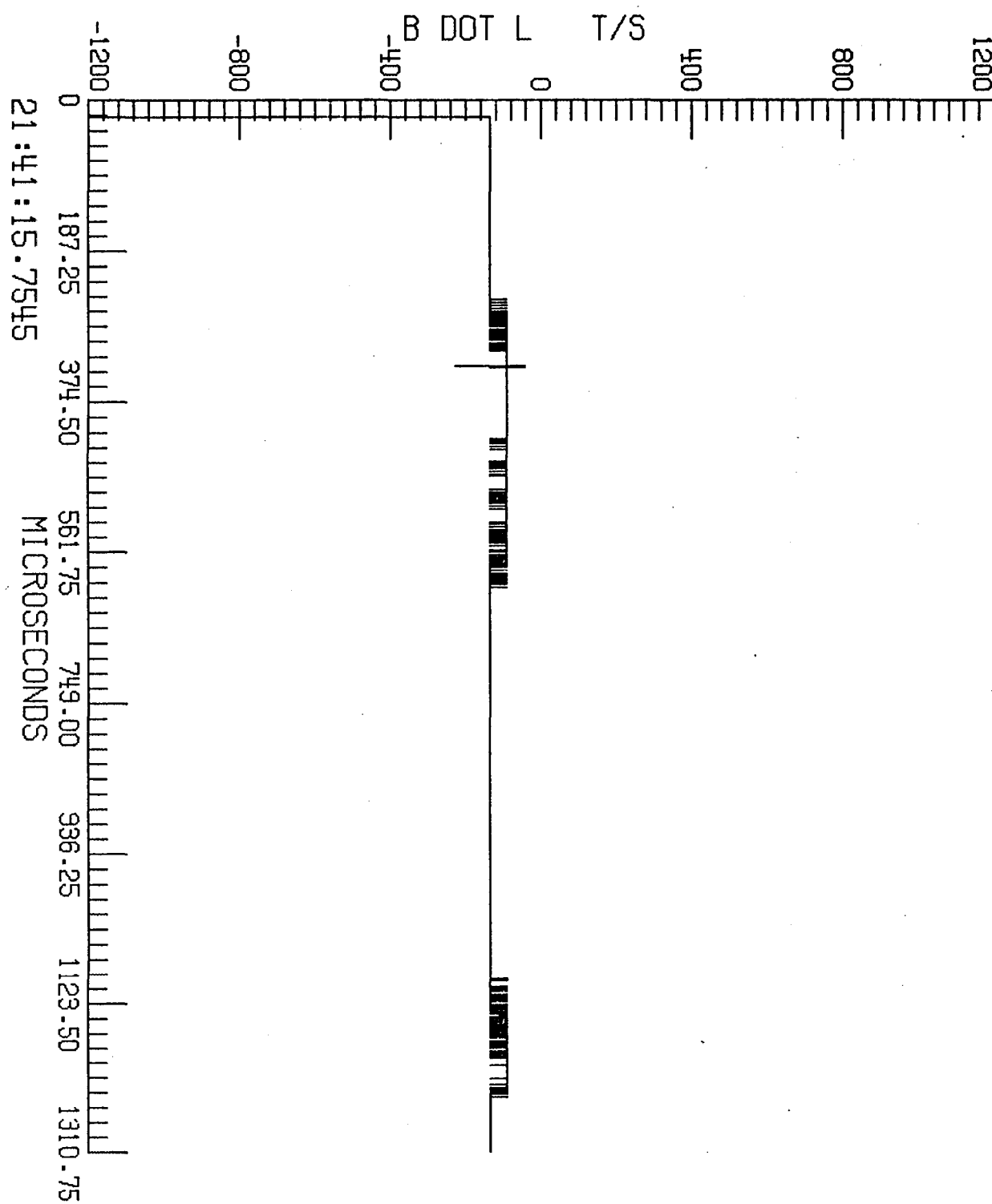
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 16 S-012

TEST NO. 83



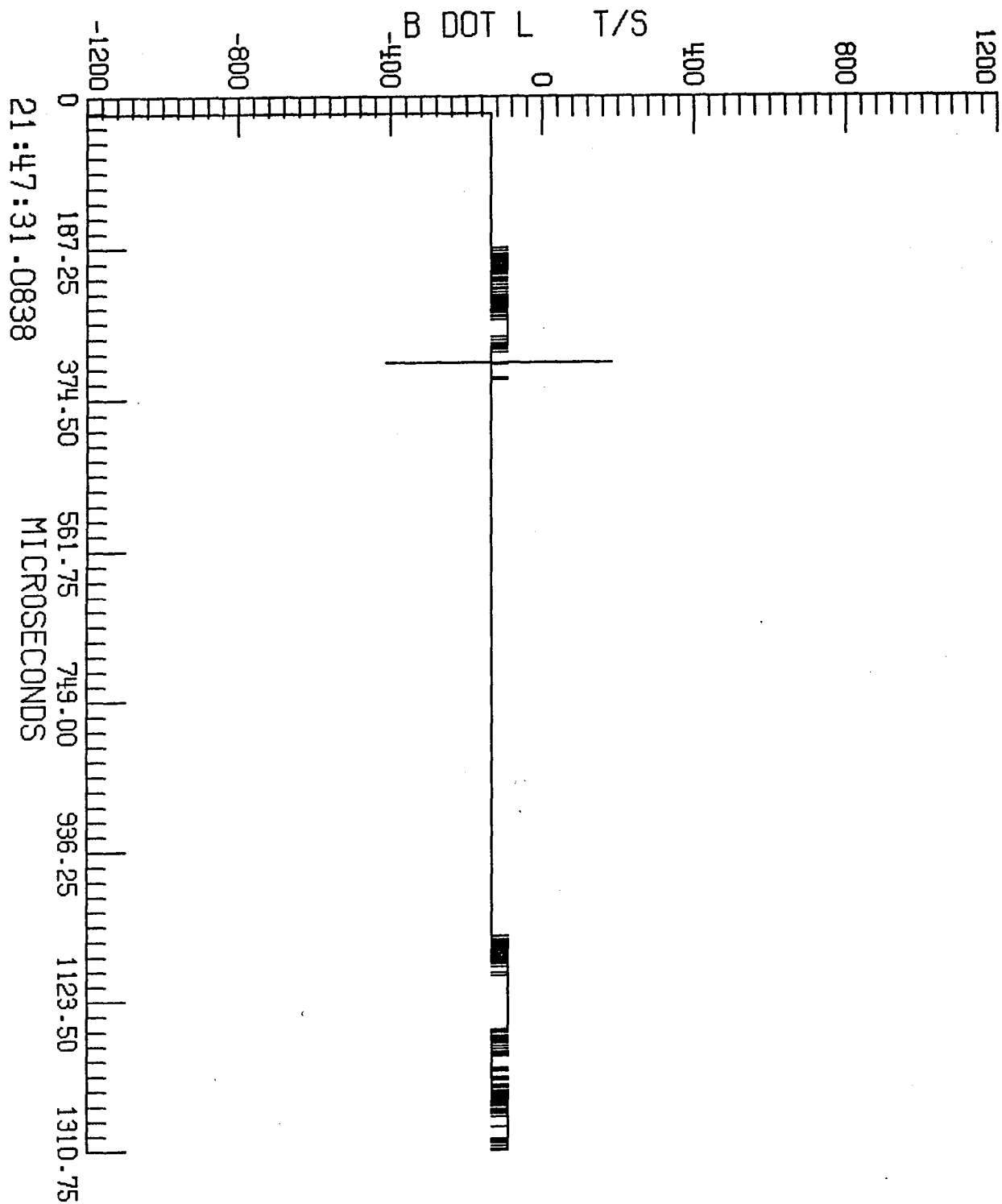
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 1 N-001

TEST NO. 83-



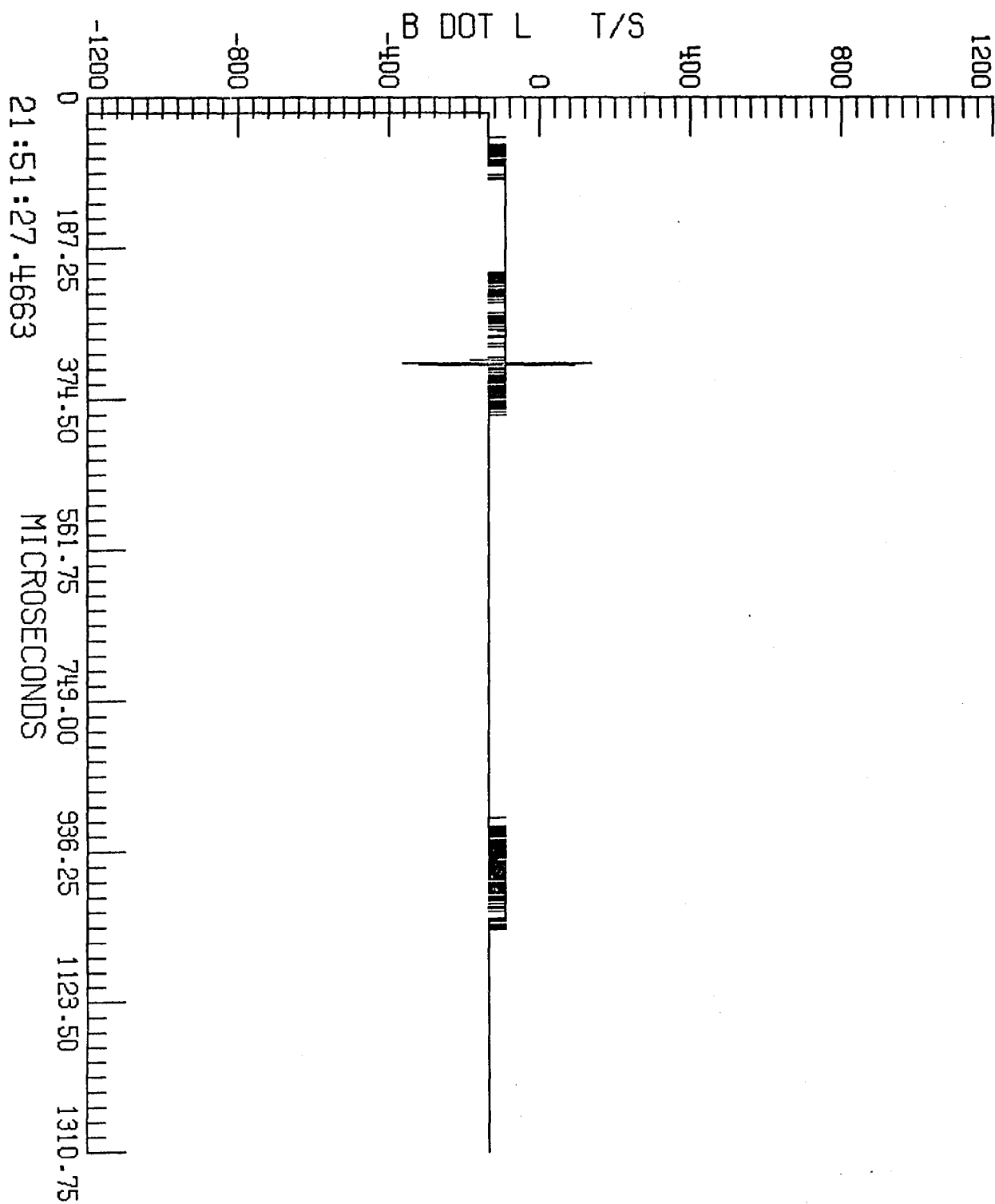
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 2 N-002

TEST NO. 83-



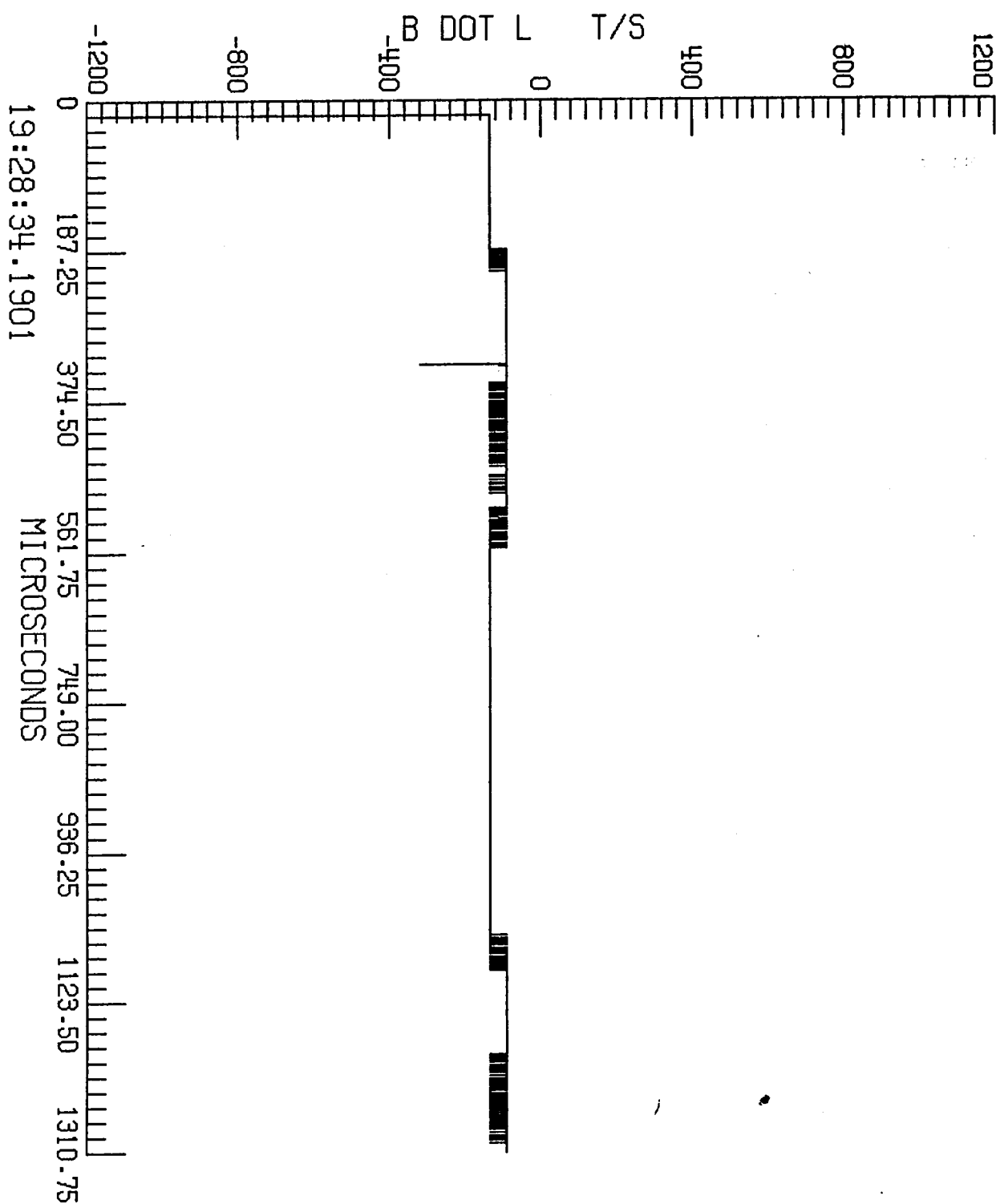
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 3 S-001

TEST NO. 83-



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 1 N-001

TEST NO. 83

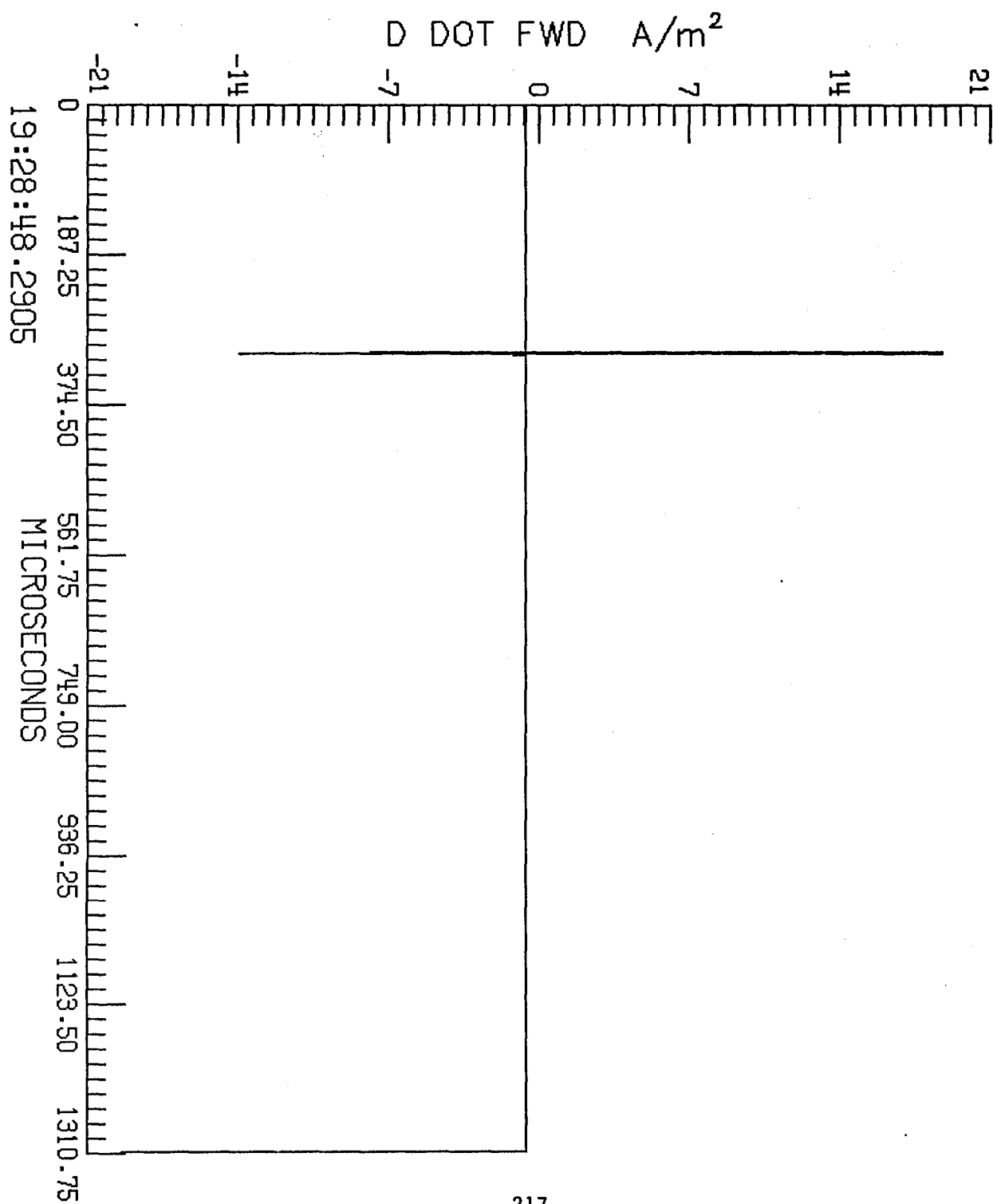


F106 LIGHTNING/TK 8/M.THOMAS

TEST NO. 83

RUN NO. 2

S-001

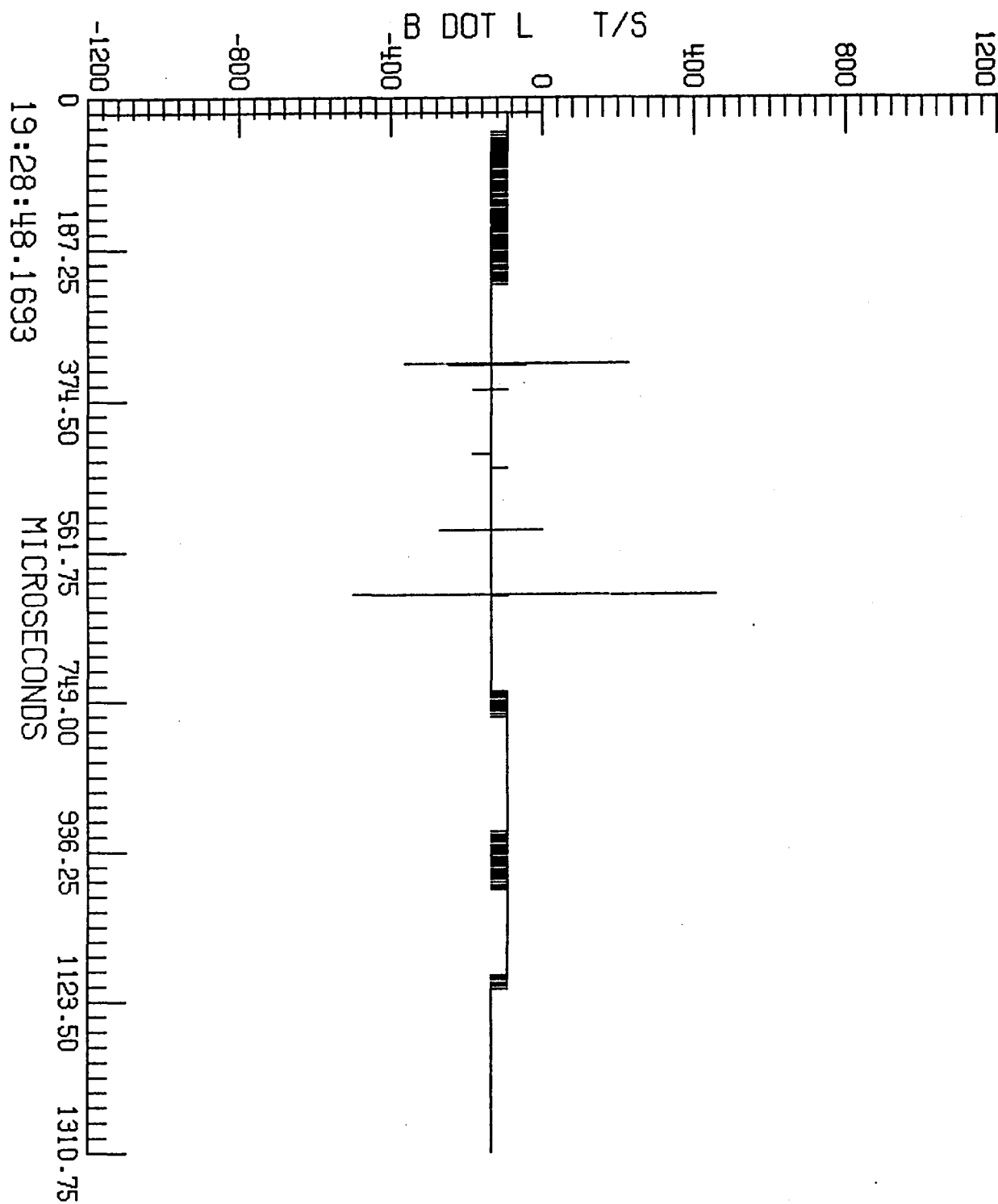


F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83

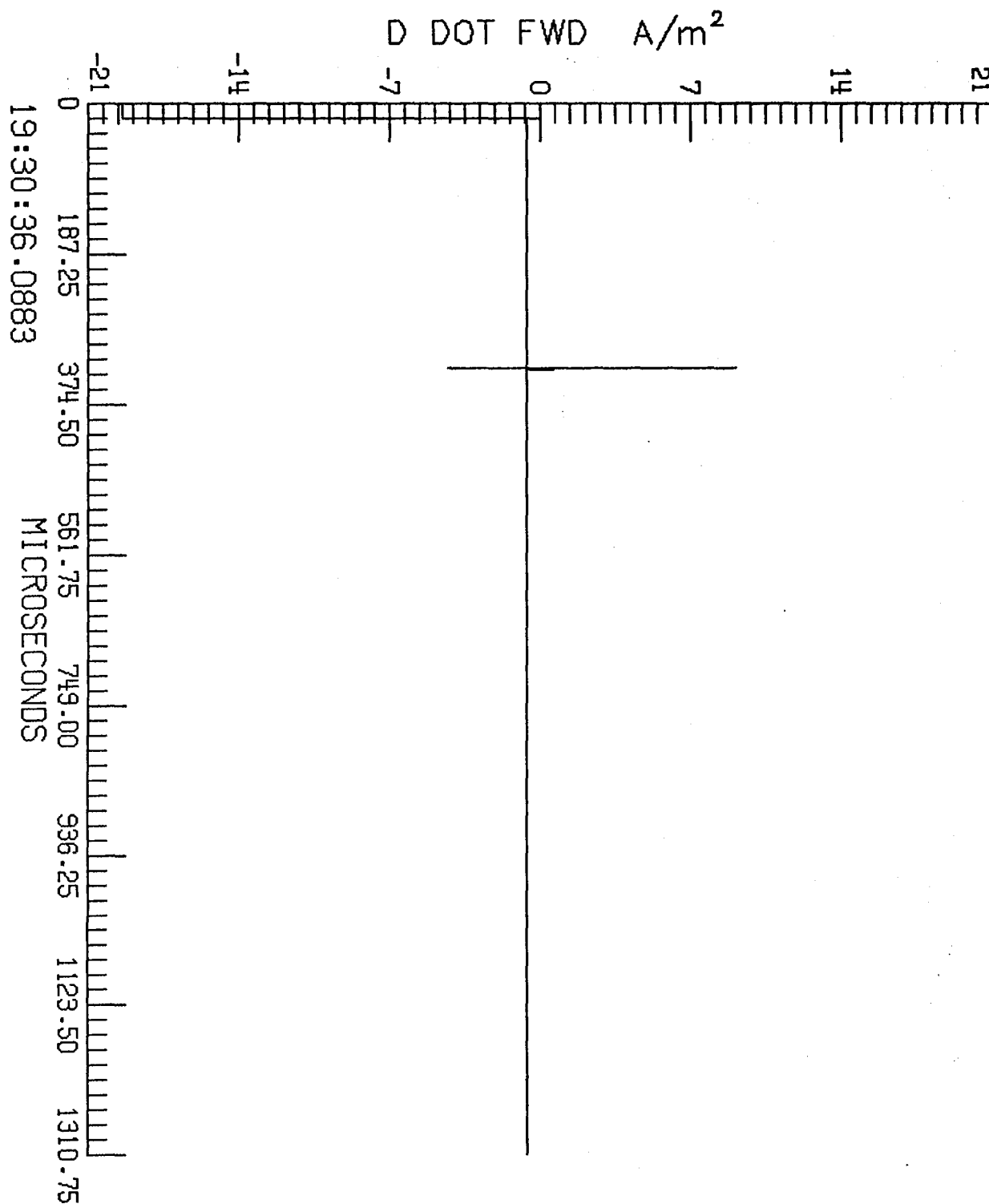
RUN NO. 2

S-001



F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 3 S-002

TEST NO. 83

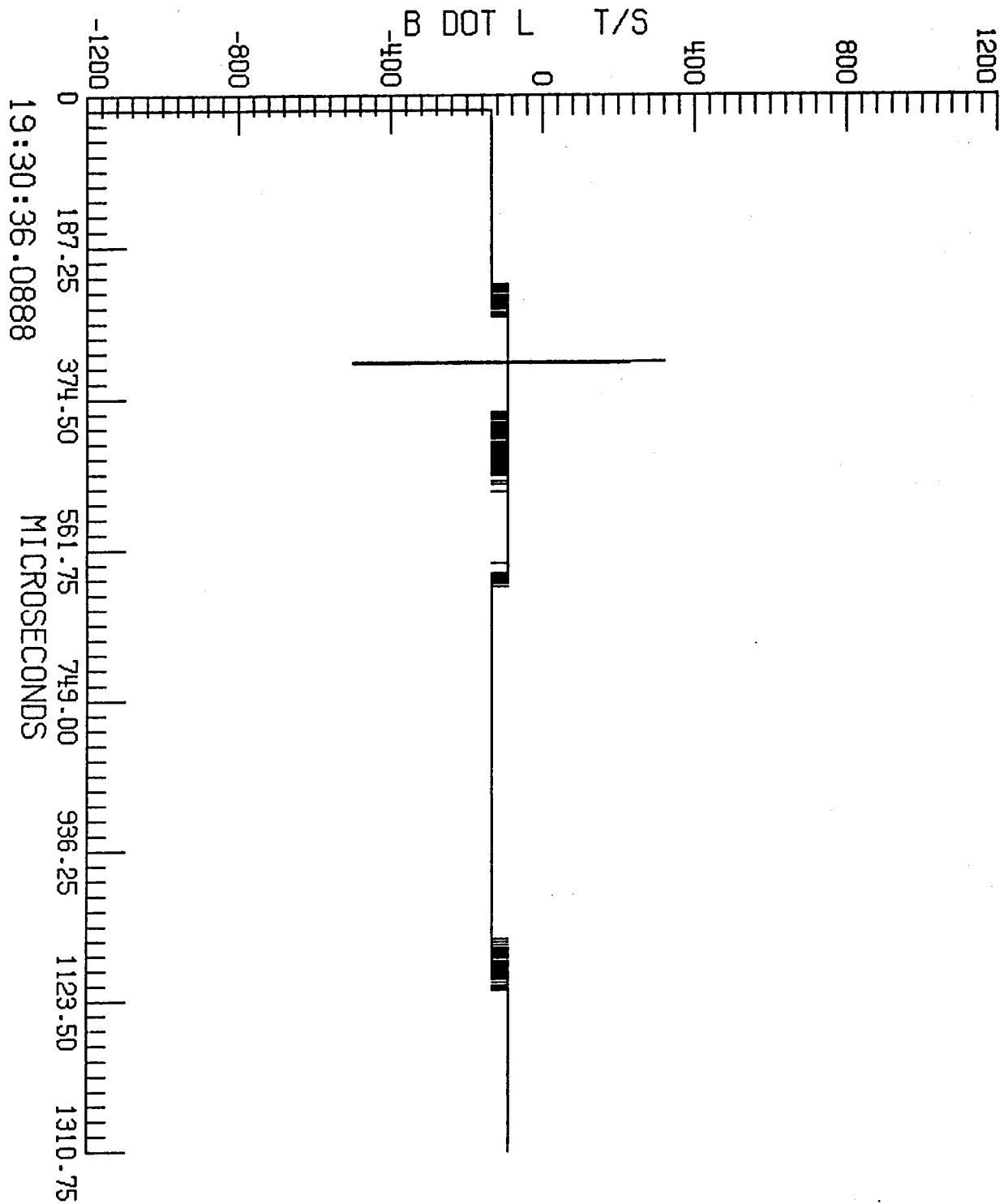


F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83

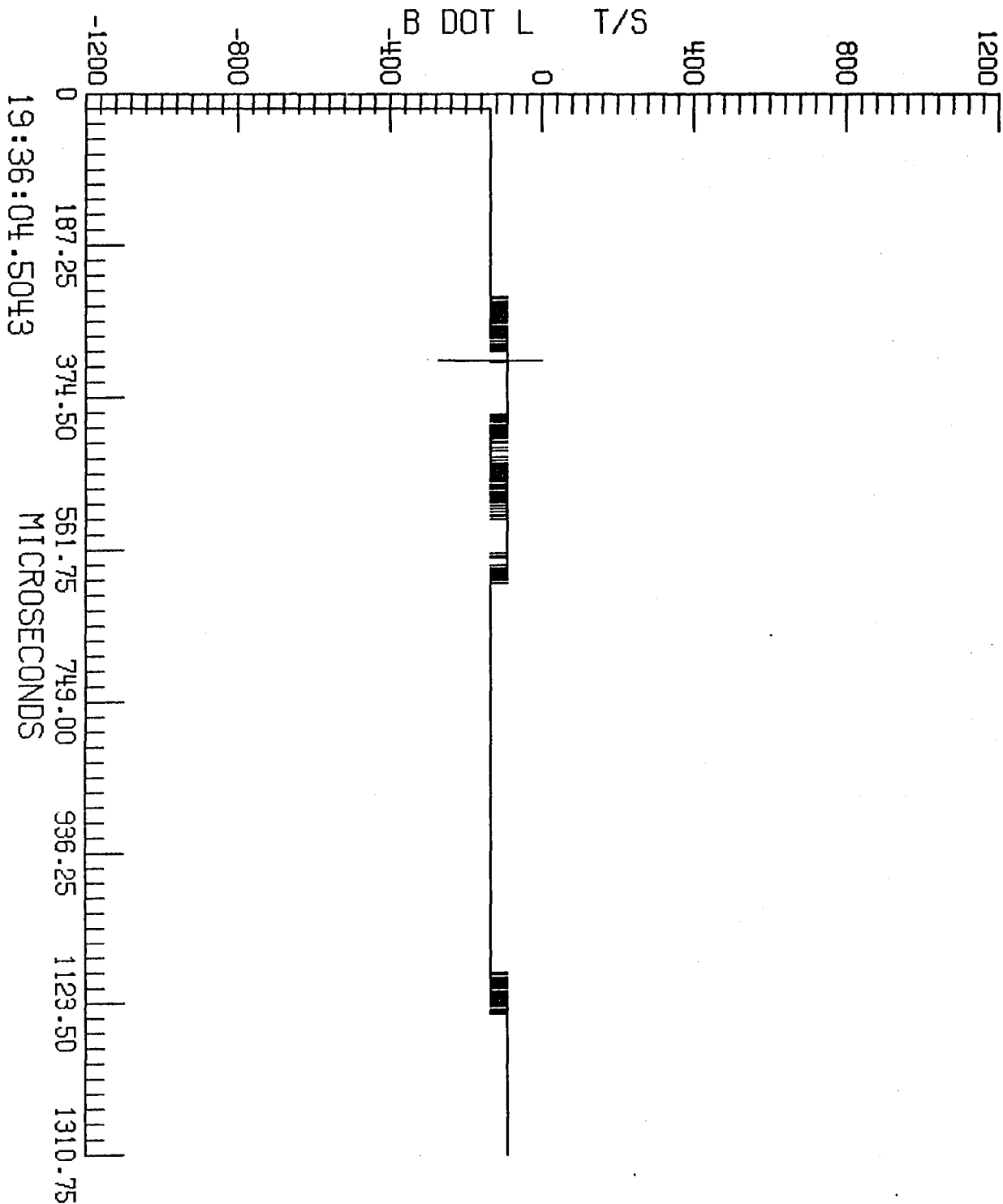
RUN NO. 3

S-002



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 4 S-003

TEST NO. 83

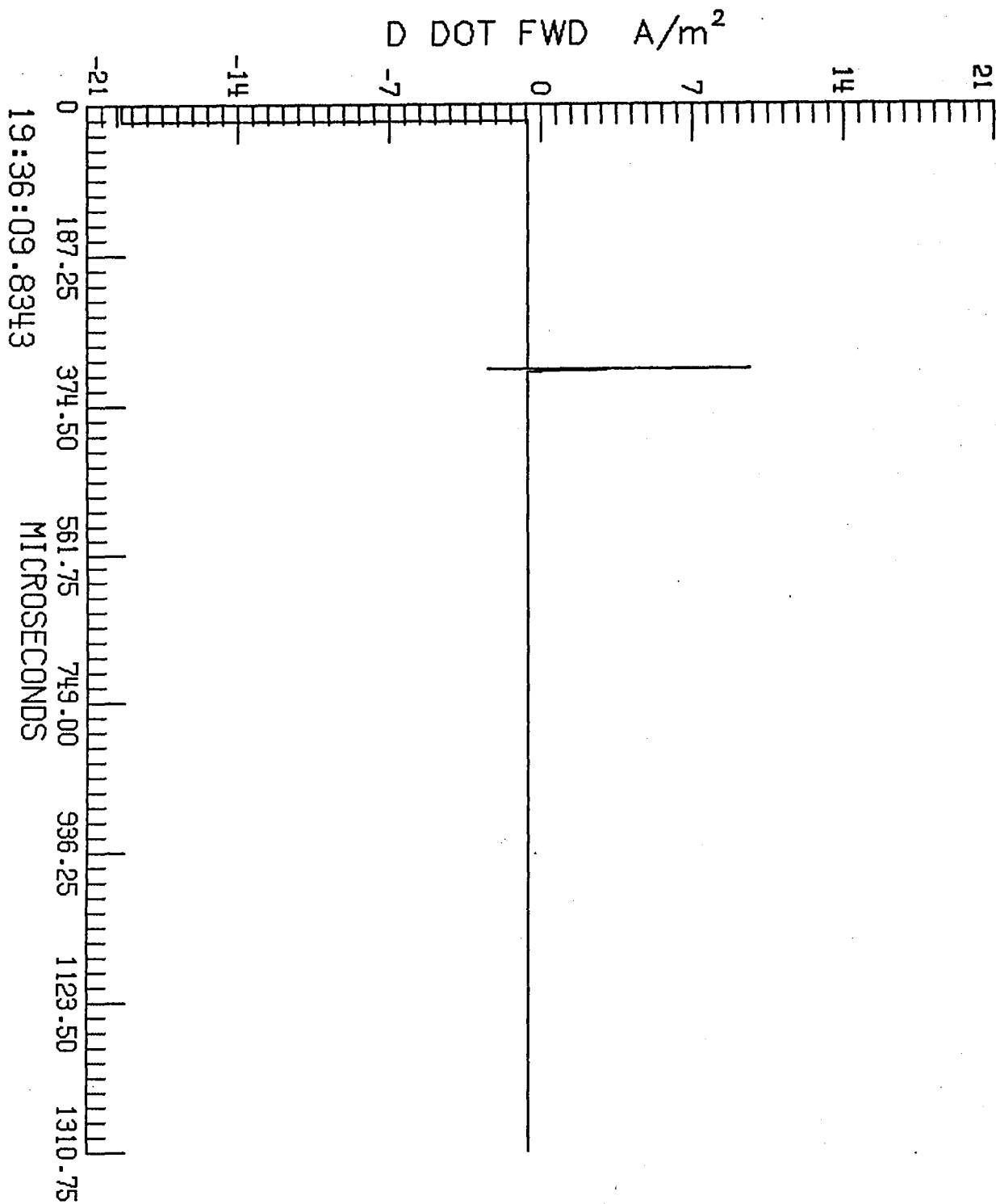


F106 LIGHTNING/TK 8/M.THOMAS

TEST NO. 83.

RUN NO. 5

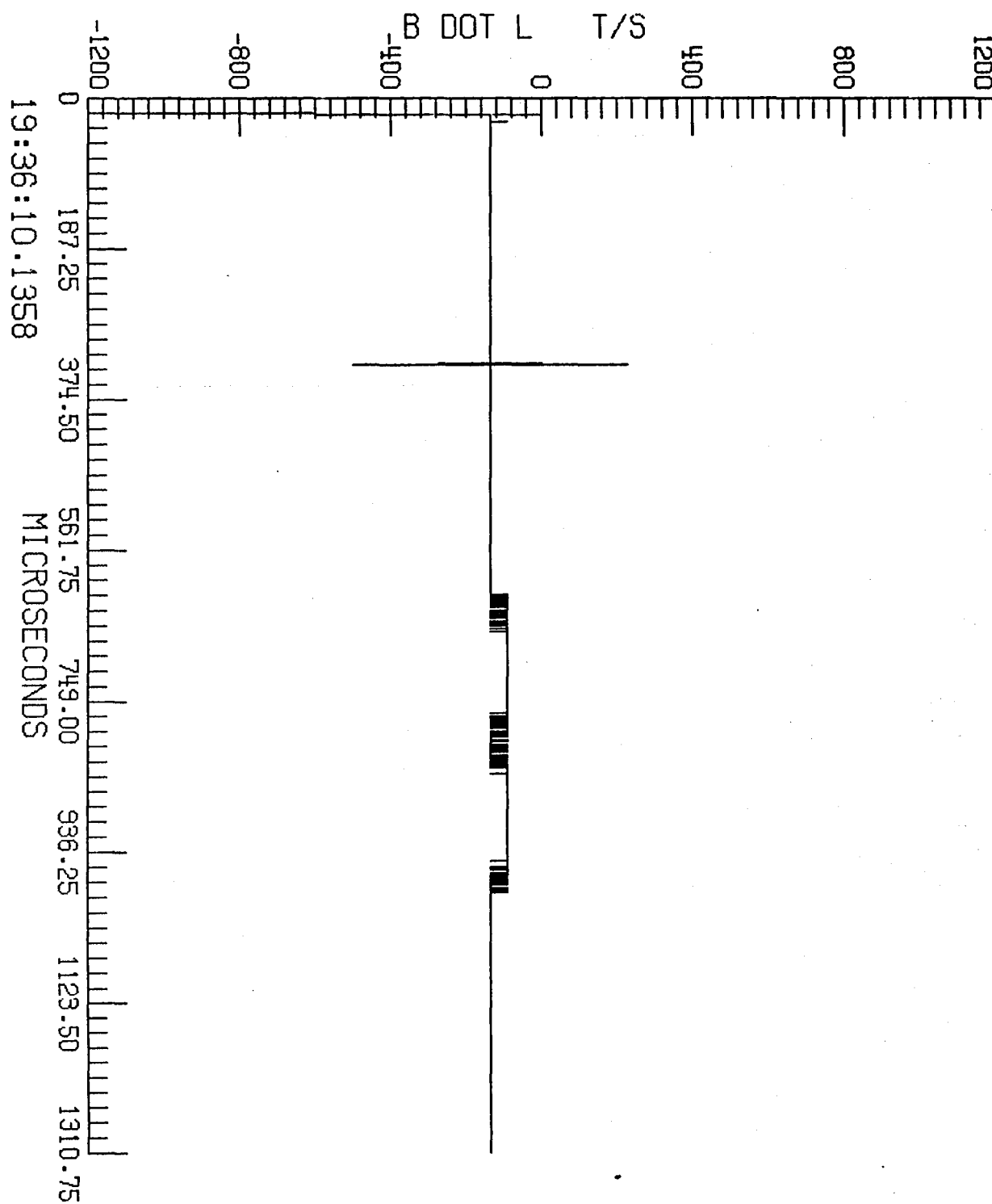
N-002



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 5

N-002

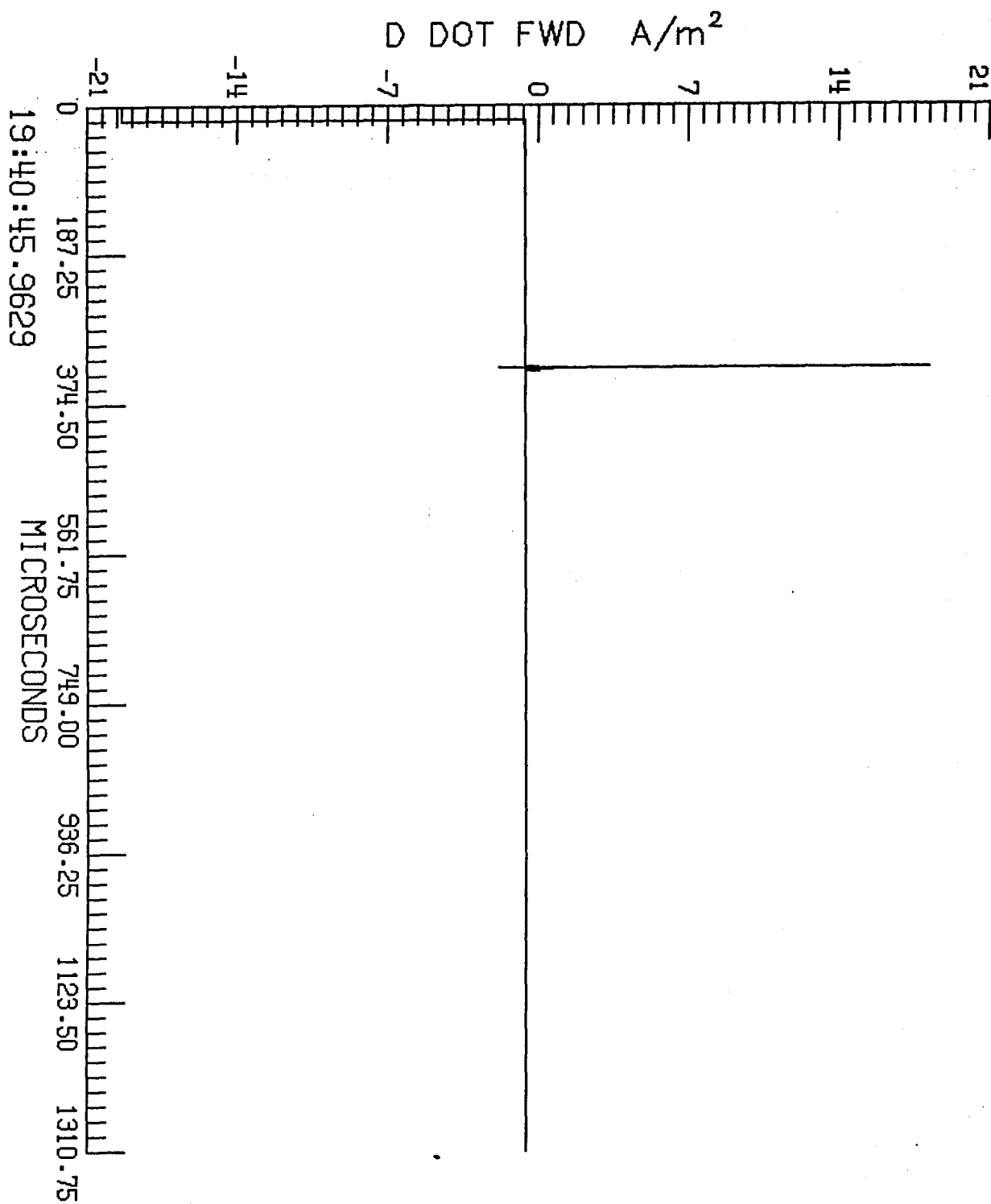
TEST NO. 83



F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 6

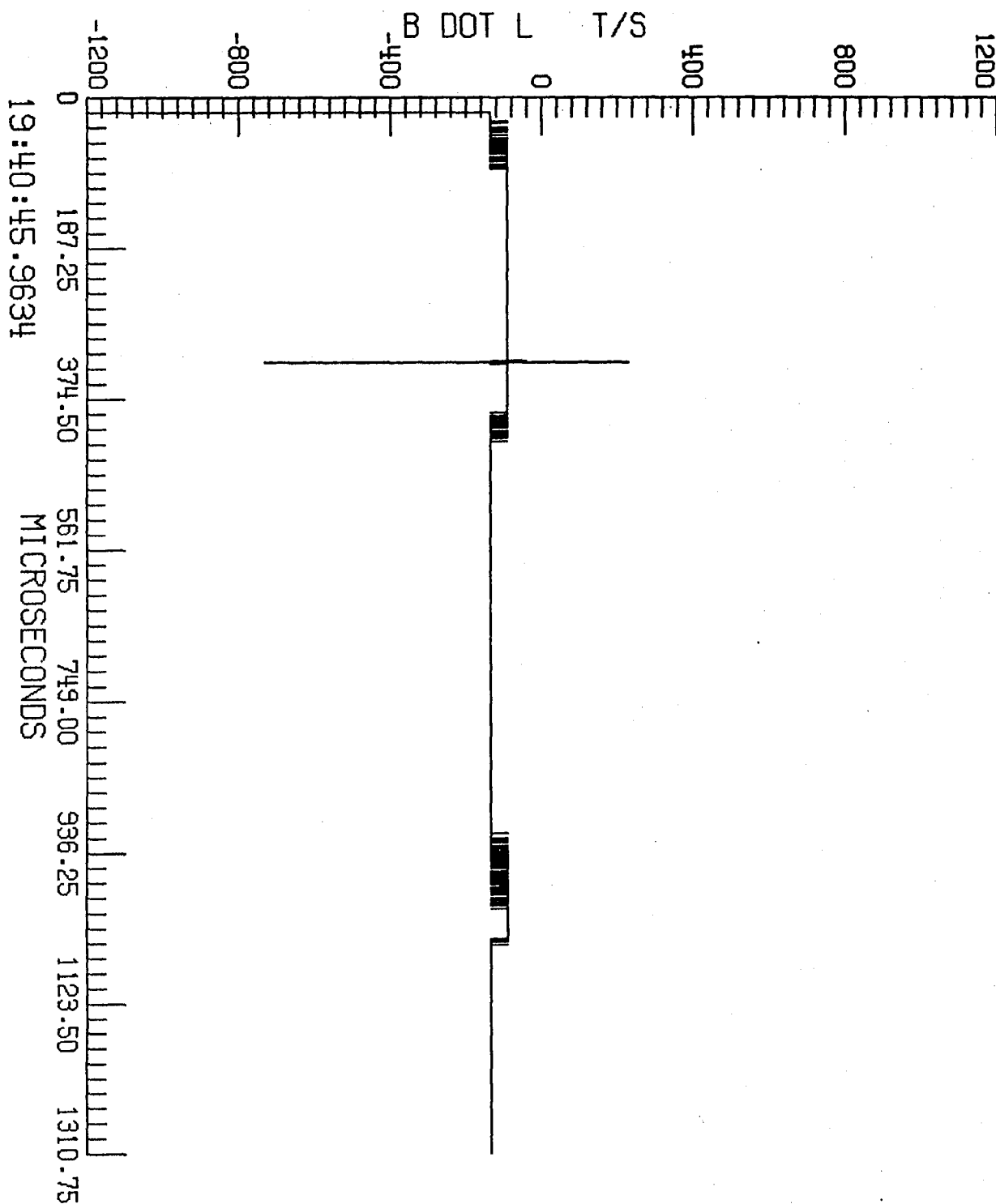
TEST NO. 83

N-003



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 6 N-003

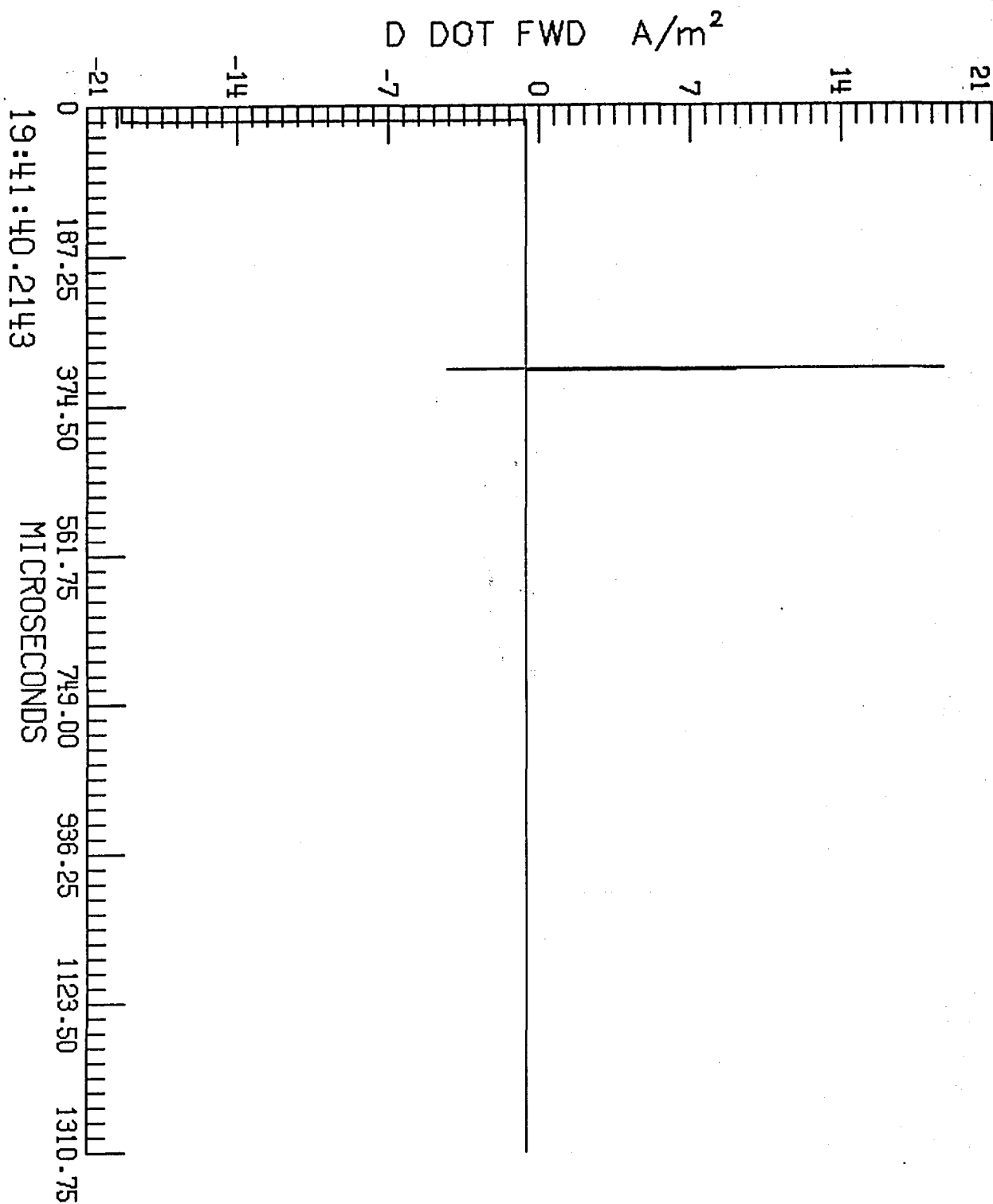
TEST NO. 83-



F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 7

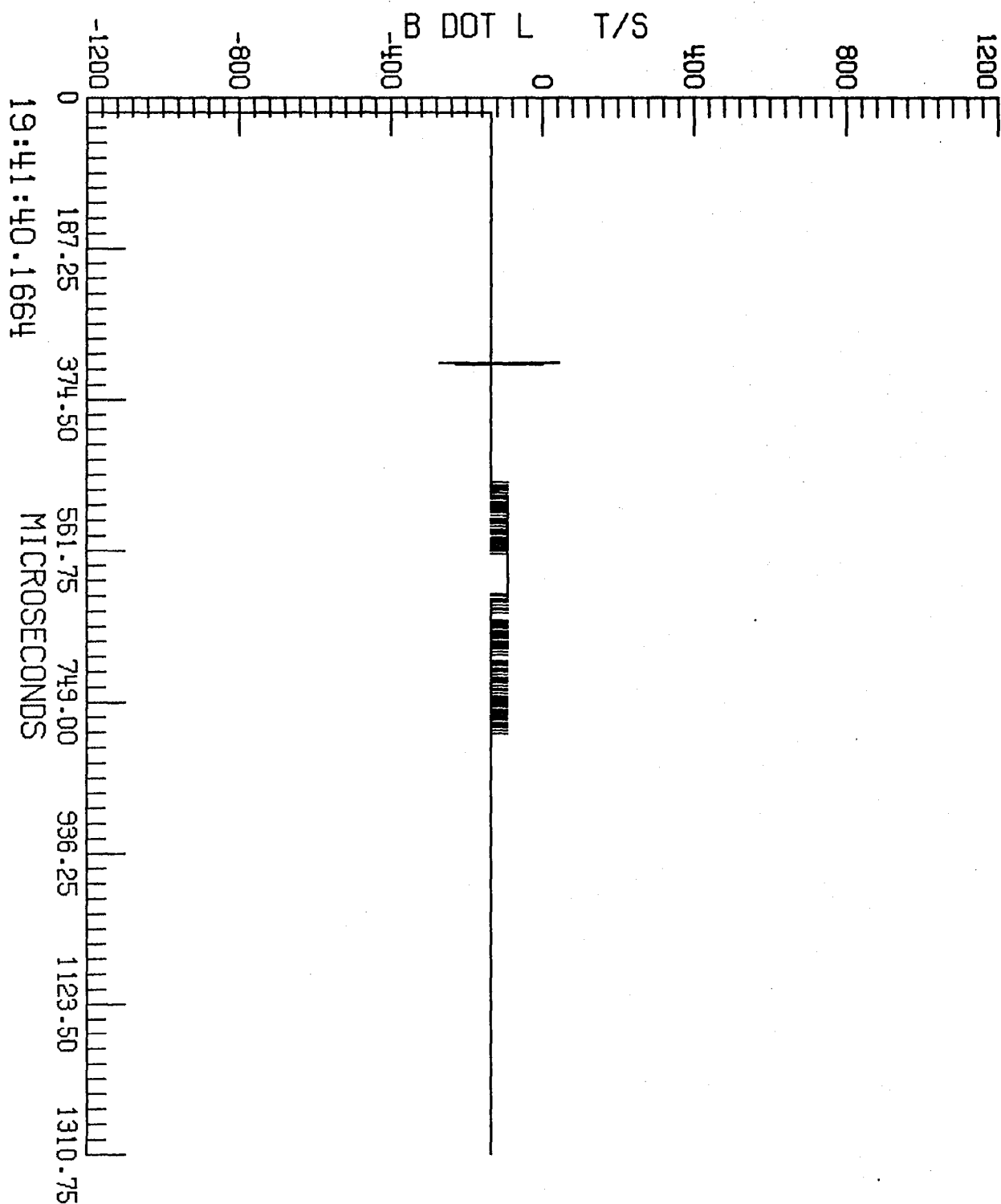
N-004

TEST NO. 83



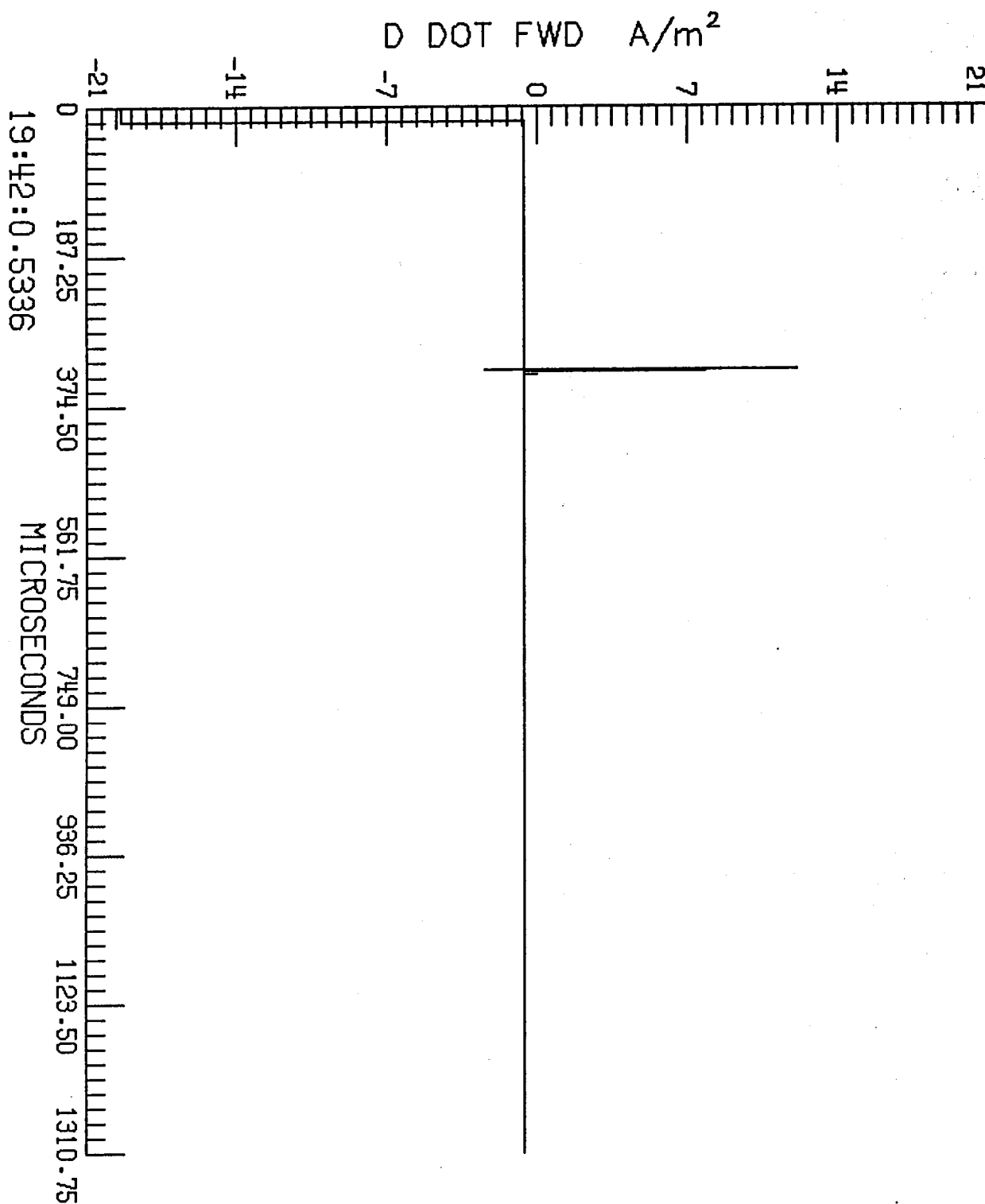
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 7 N-004

TEST NO. 83-



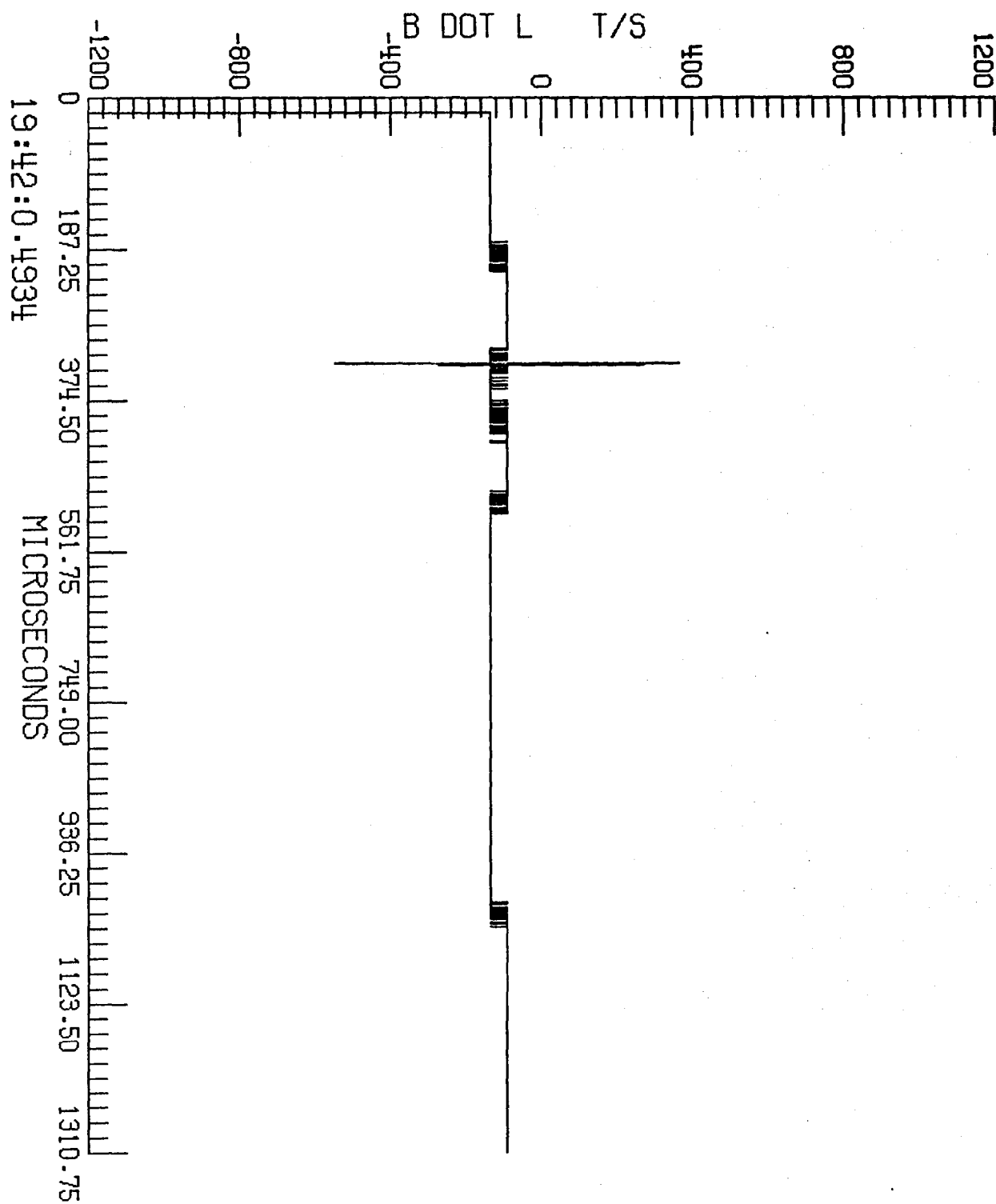
F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 8 N-005

TEST NO. 83



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 8 N-005

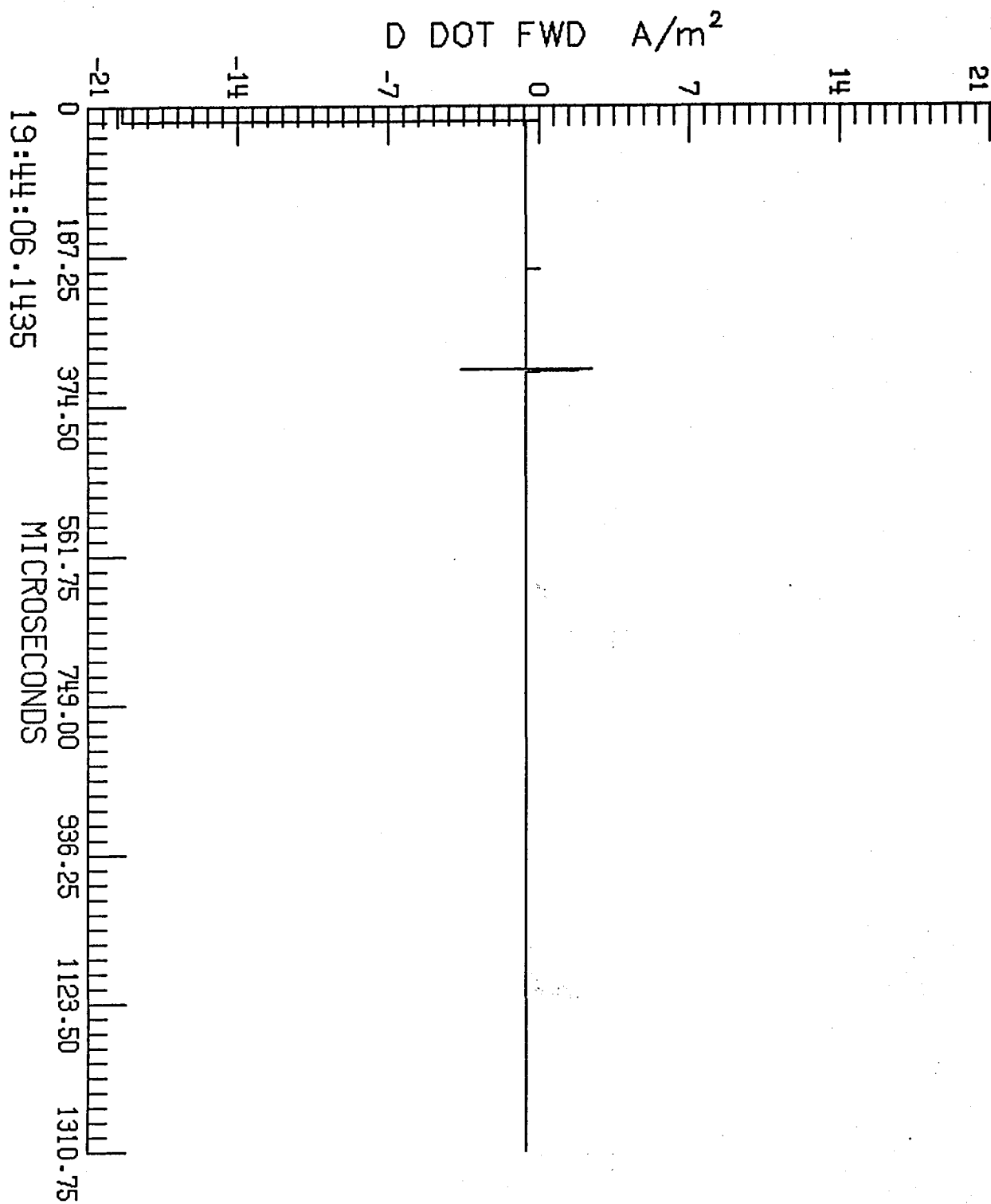
TEST NO. 83.



F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 9

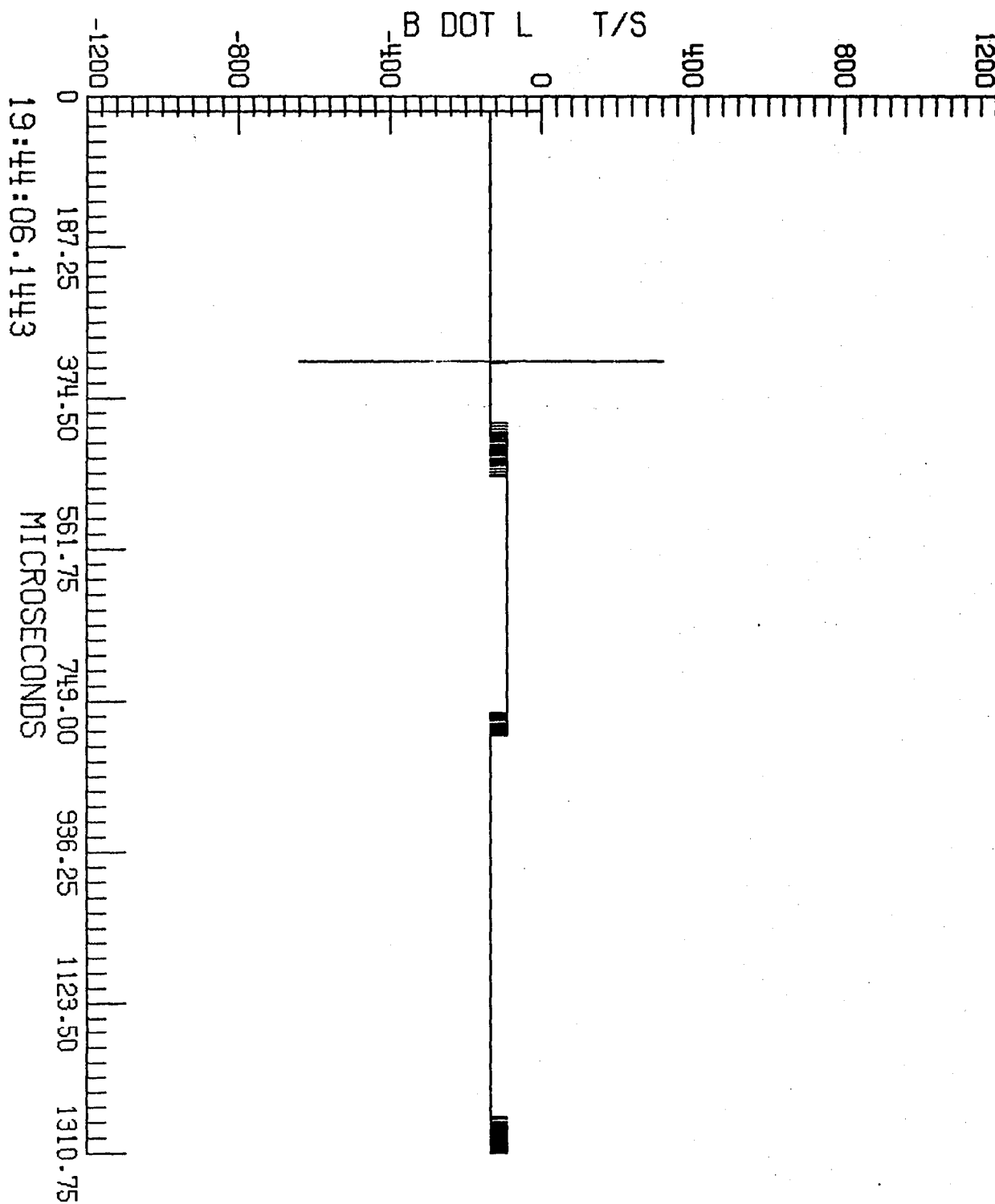
N-006

TEST NO. 83.



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 9 N-006

TEST NO. 83-

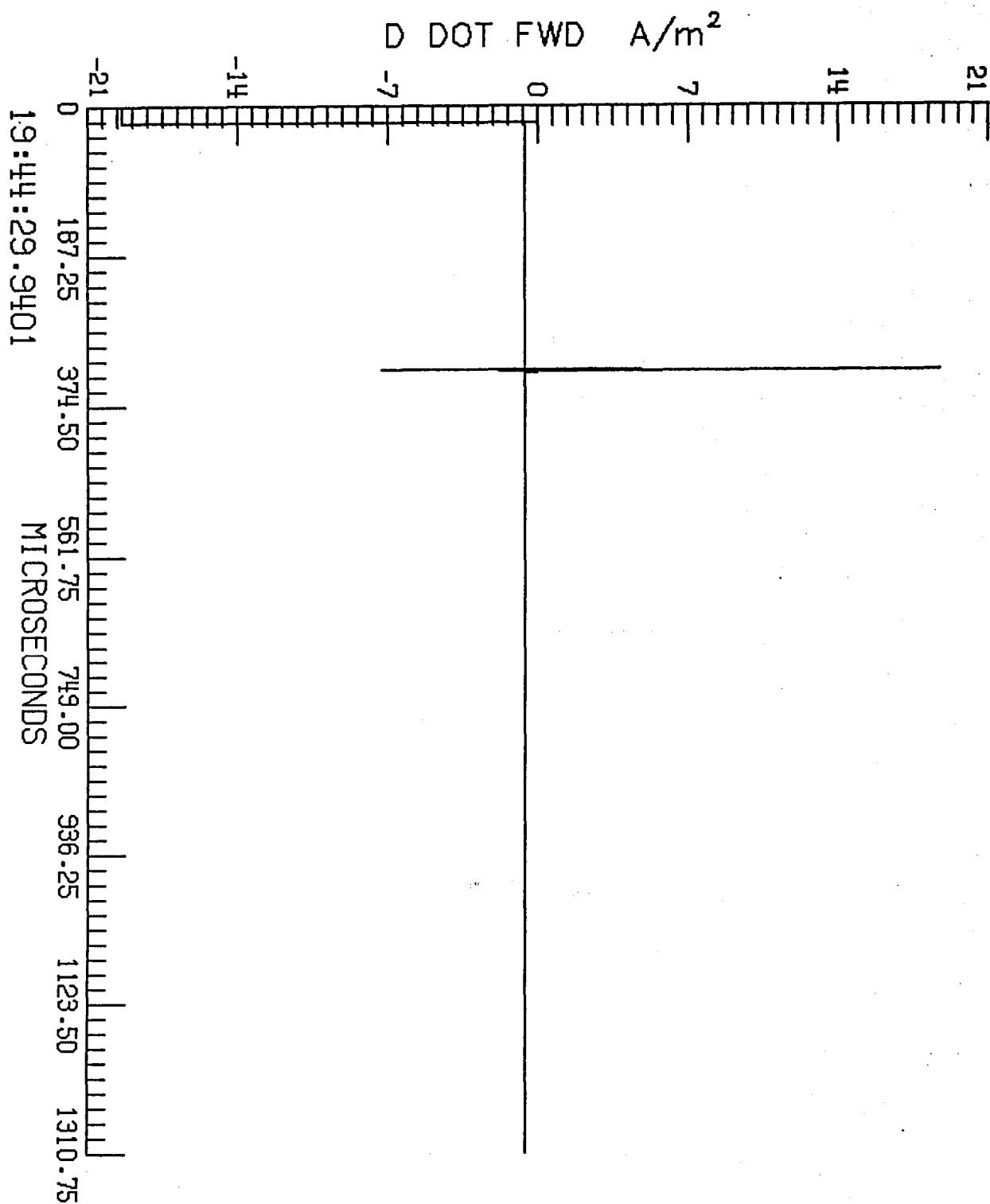


F106 LIGHTNING/TK 8/M.THOMAS

TEST NO. 83

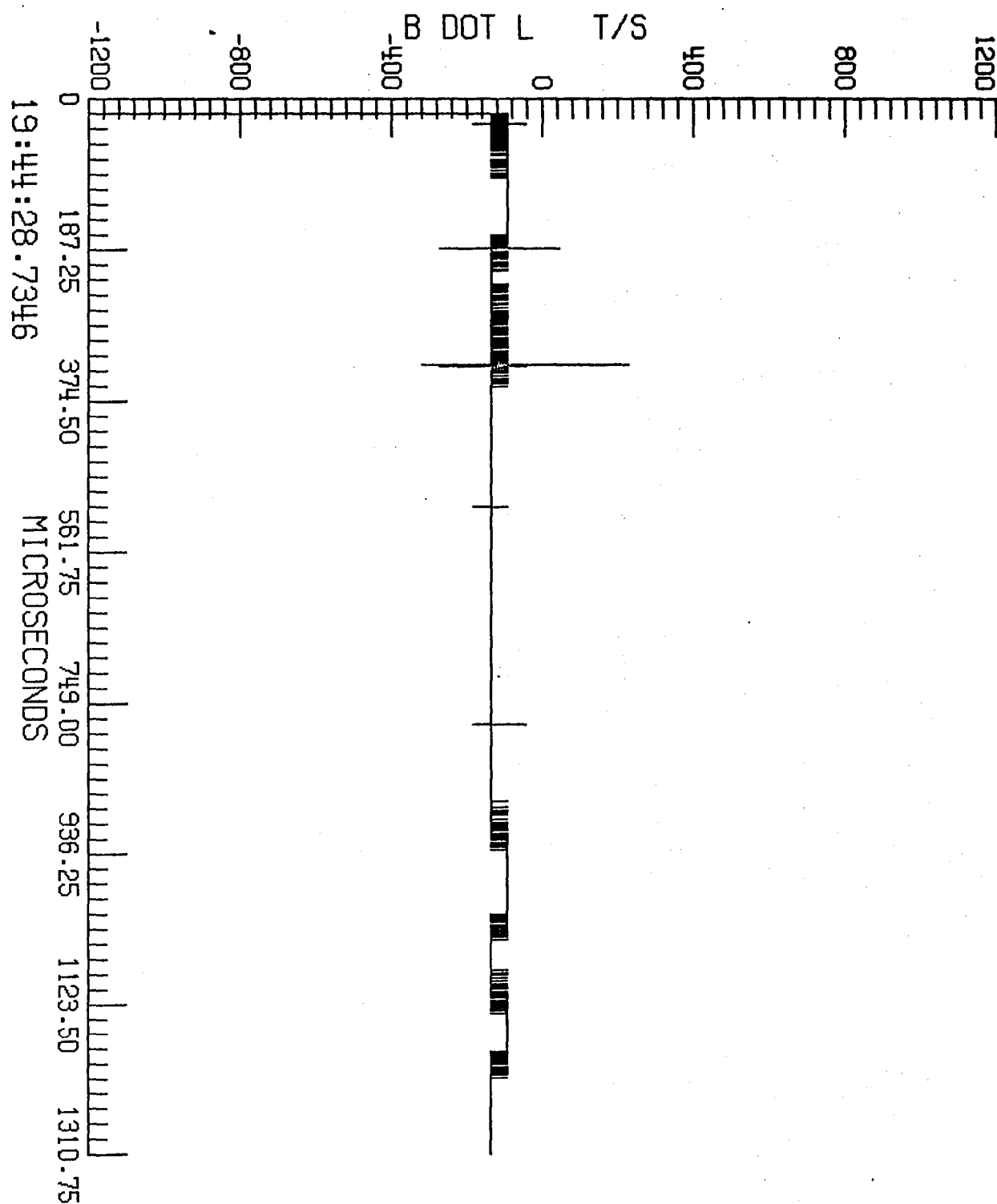
RUN NO. 10

N-007



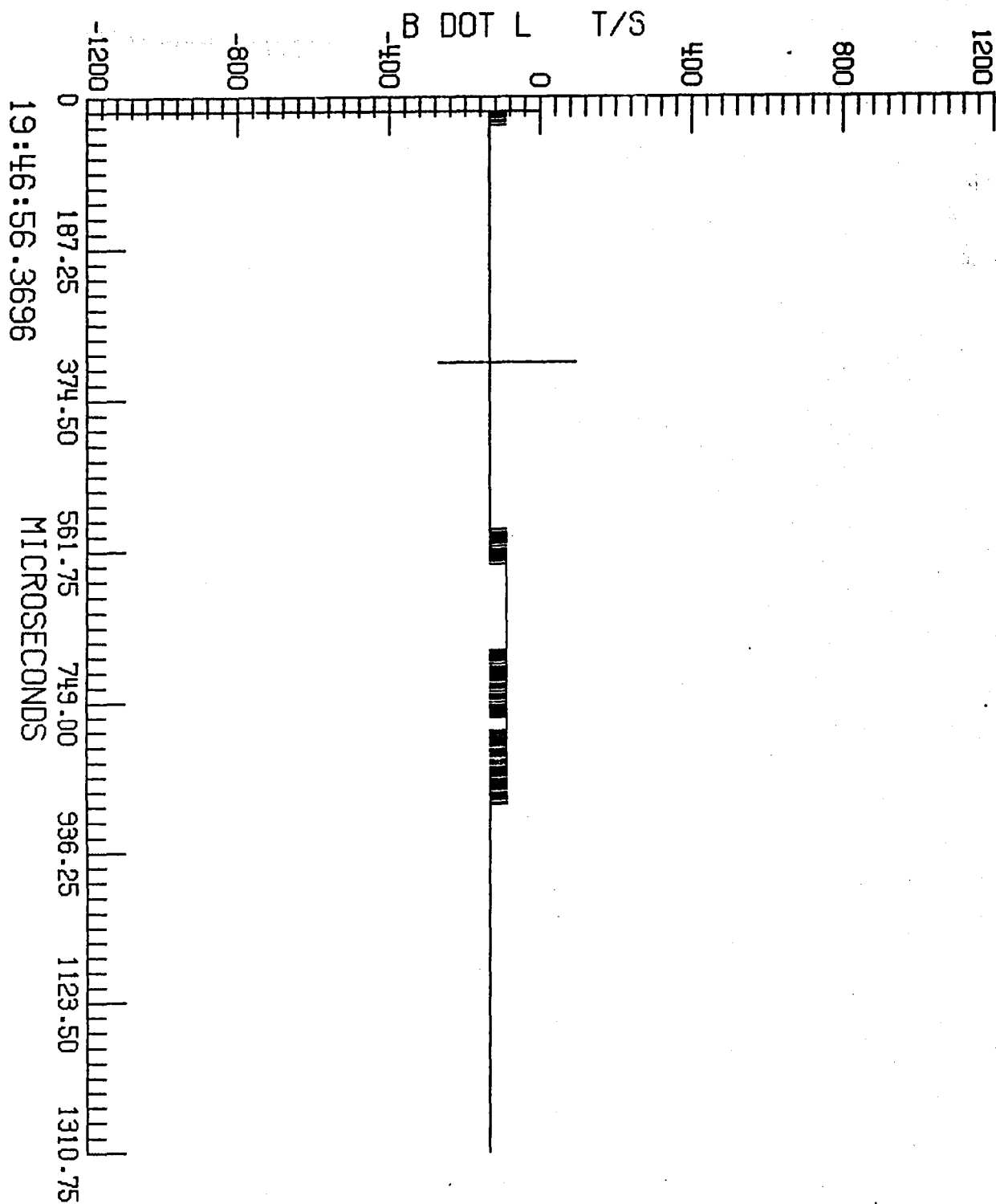
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 10 N-007

TEST NO. 83



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 11 N-008

TEST NO. 83

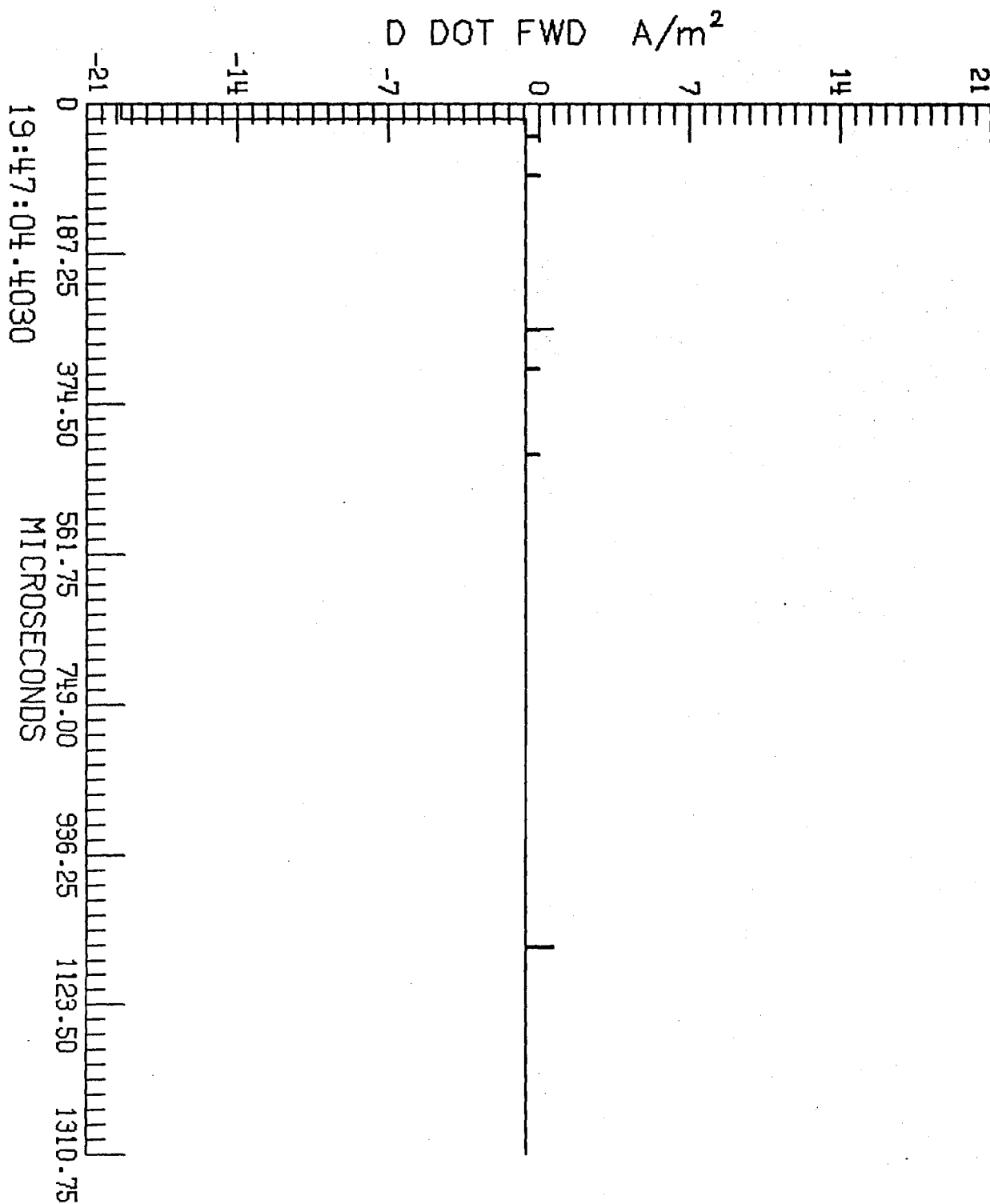


F106 LIGHTNING/TK 8/M.THOMAS

TEST NO. 83

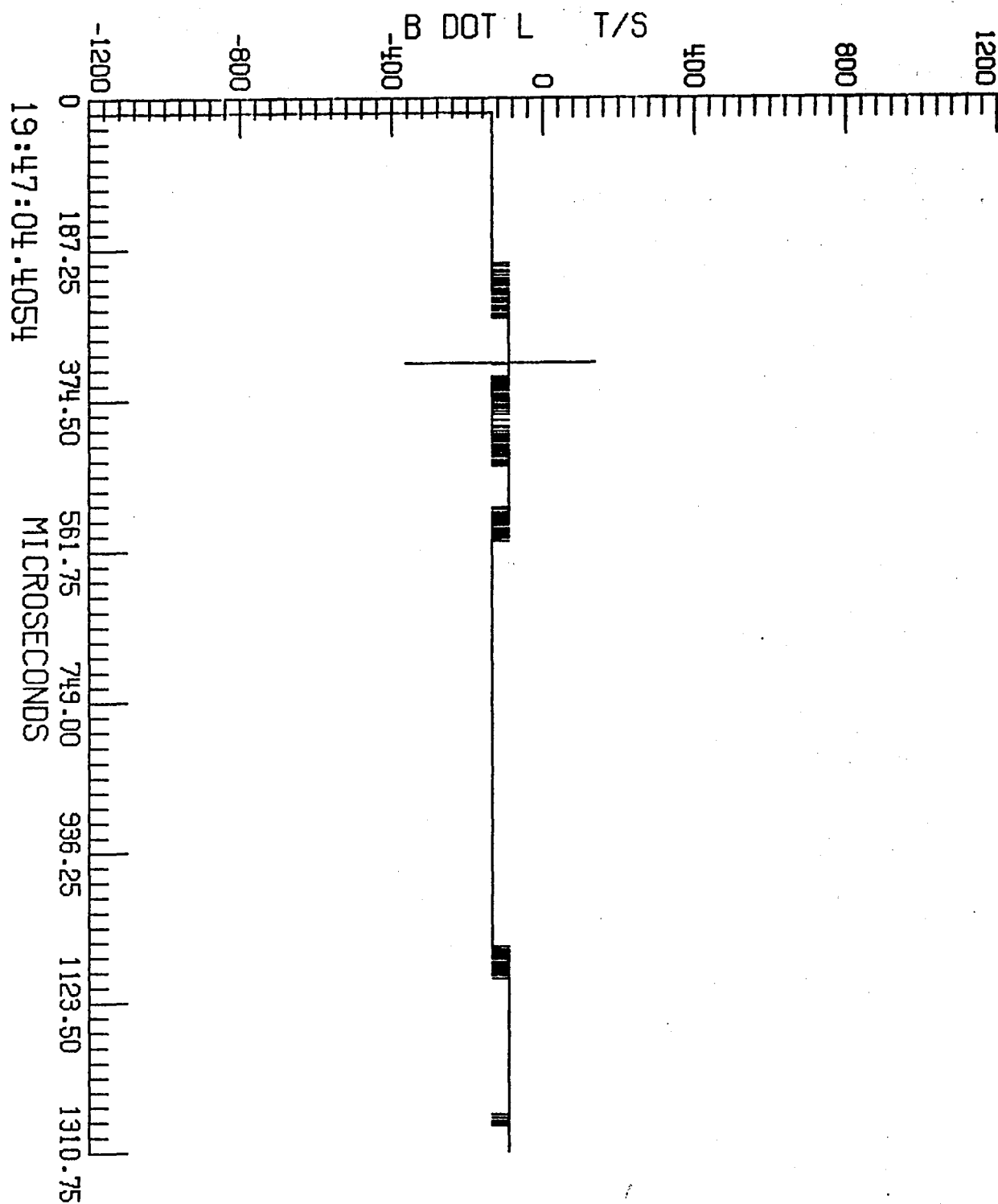
RUN NO. 12

S-006



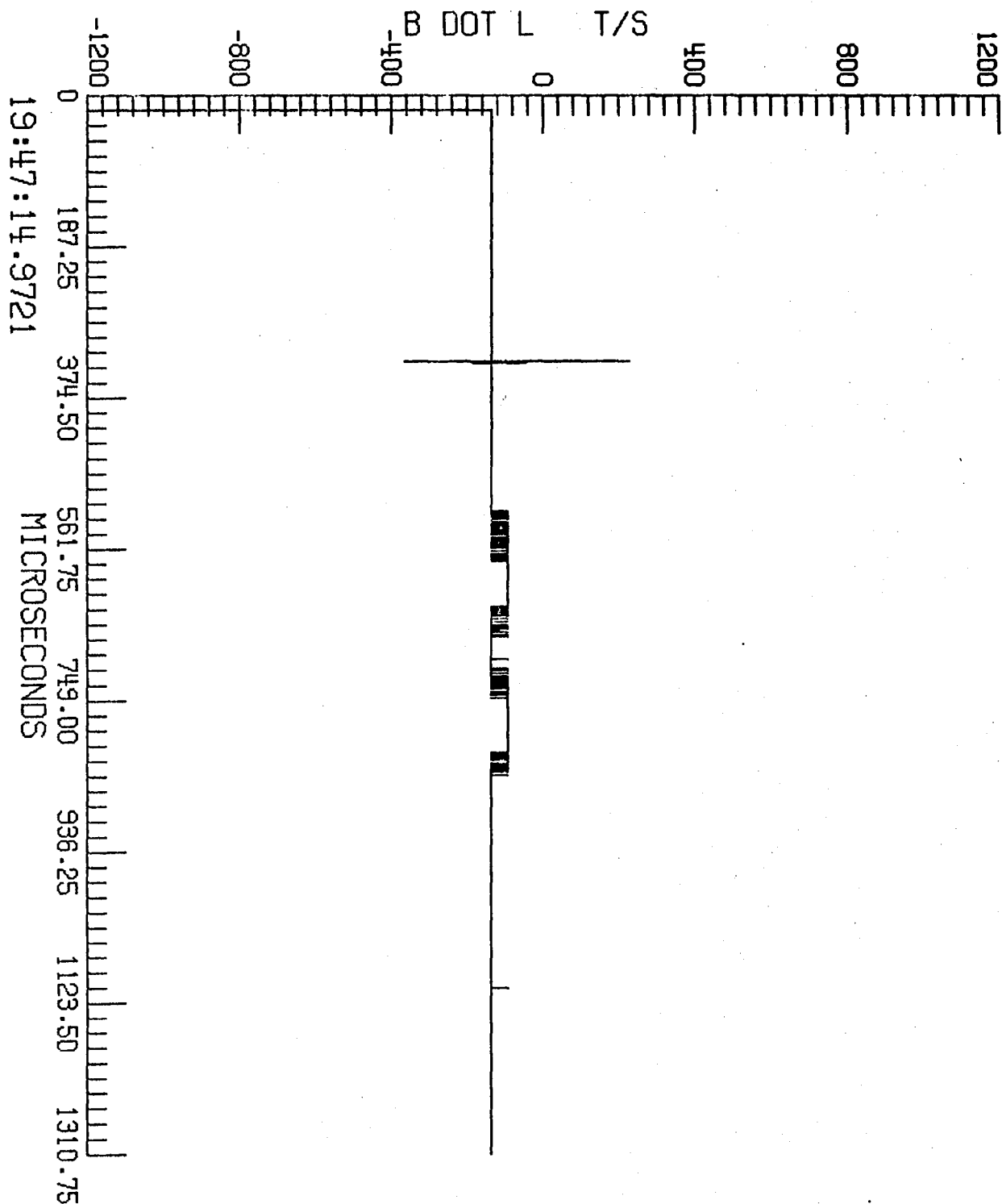
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 12 S-006

TEST NO. 83



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 13 S-008

TEST NO. 83-

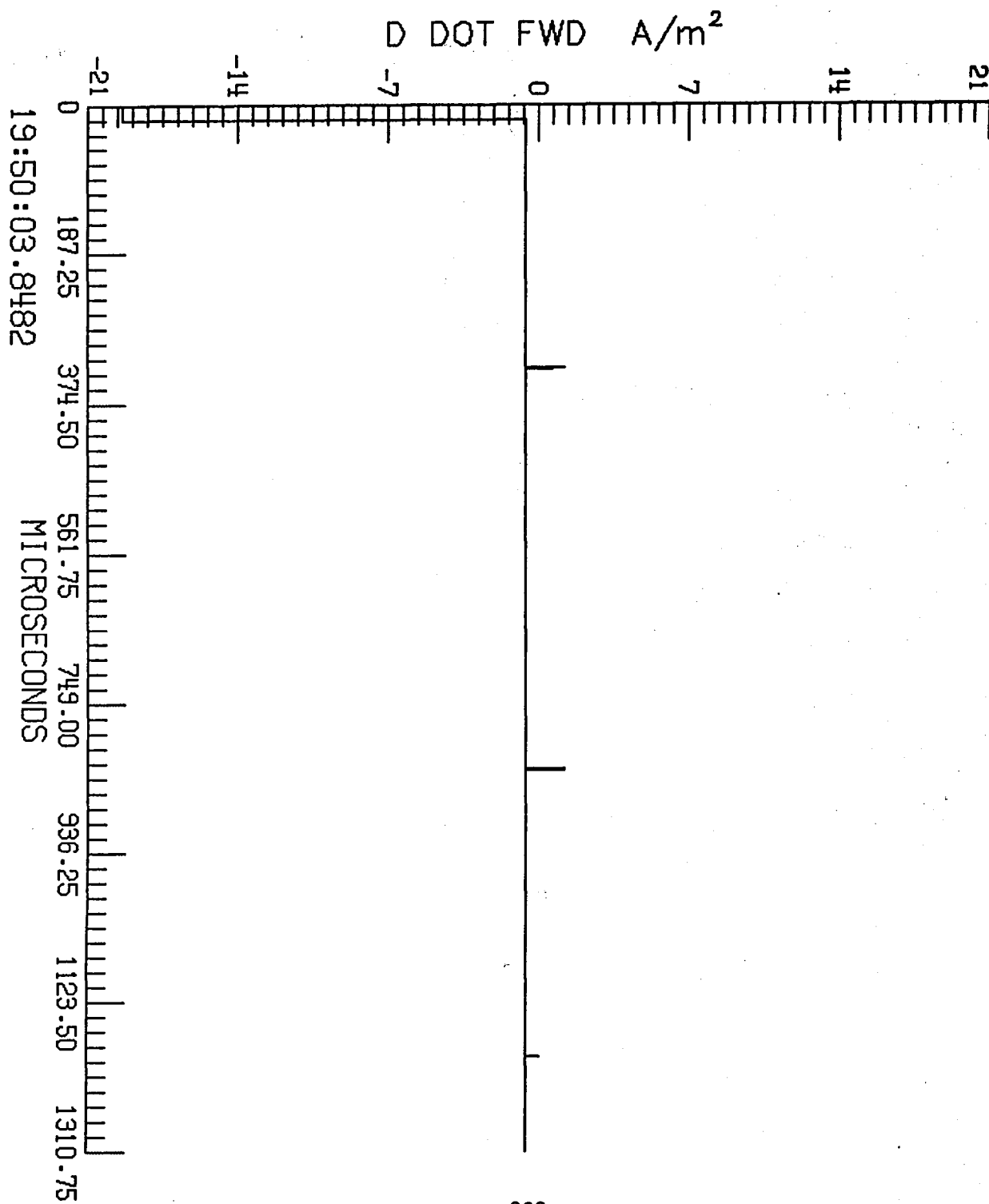


F106 LIGHTNING/TK 8/M.THOMAS

TEST NO. 83.

RUN NO. 14

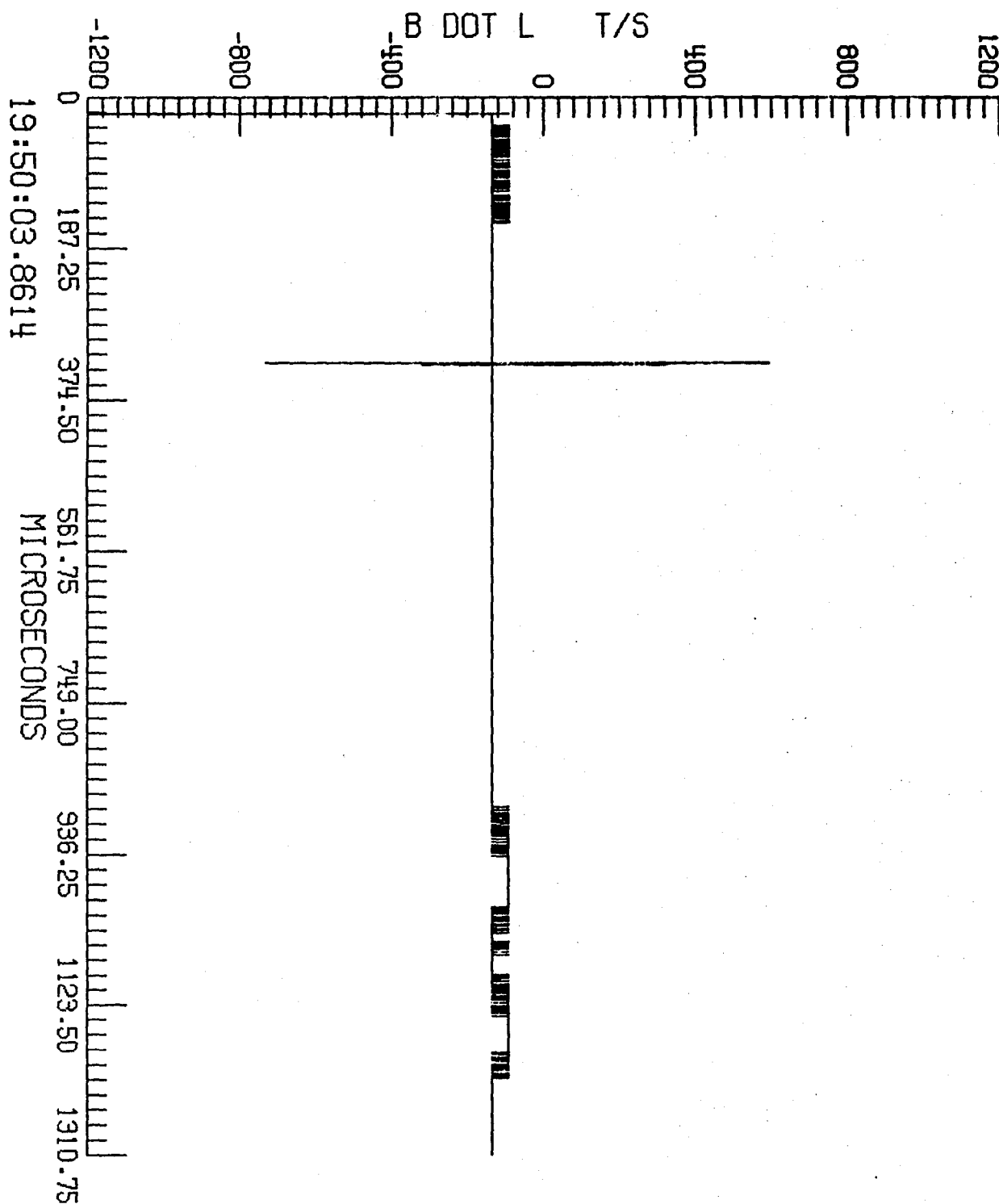
N-009



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 14

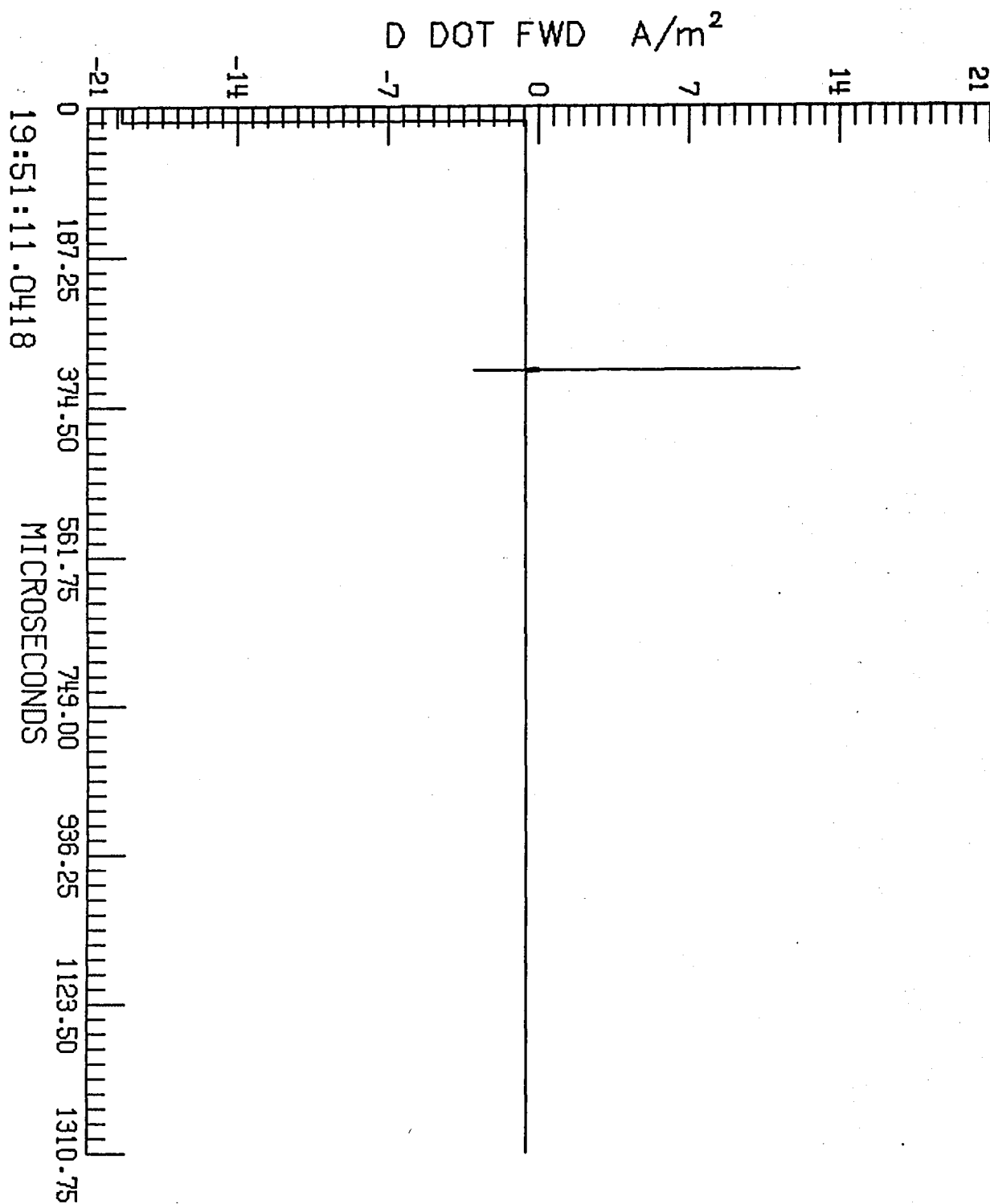
TEST NO. 83

N-009



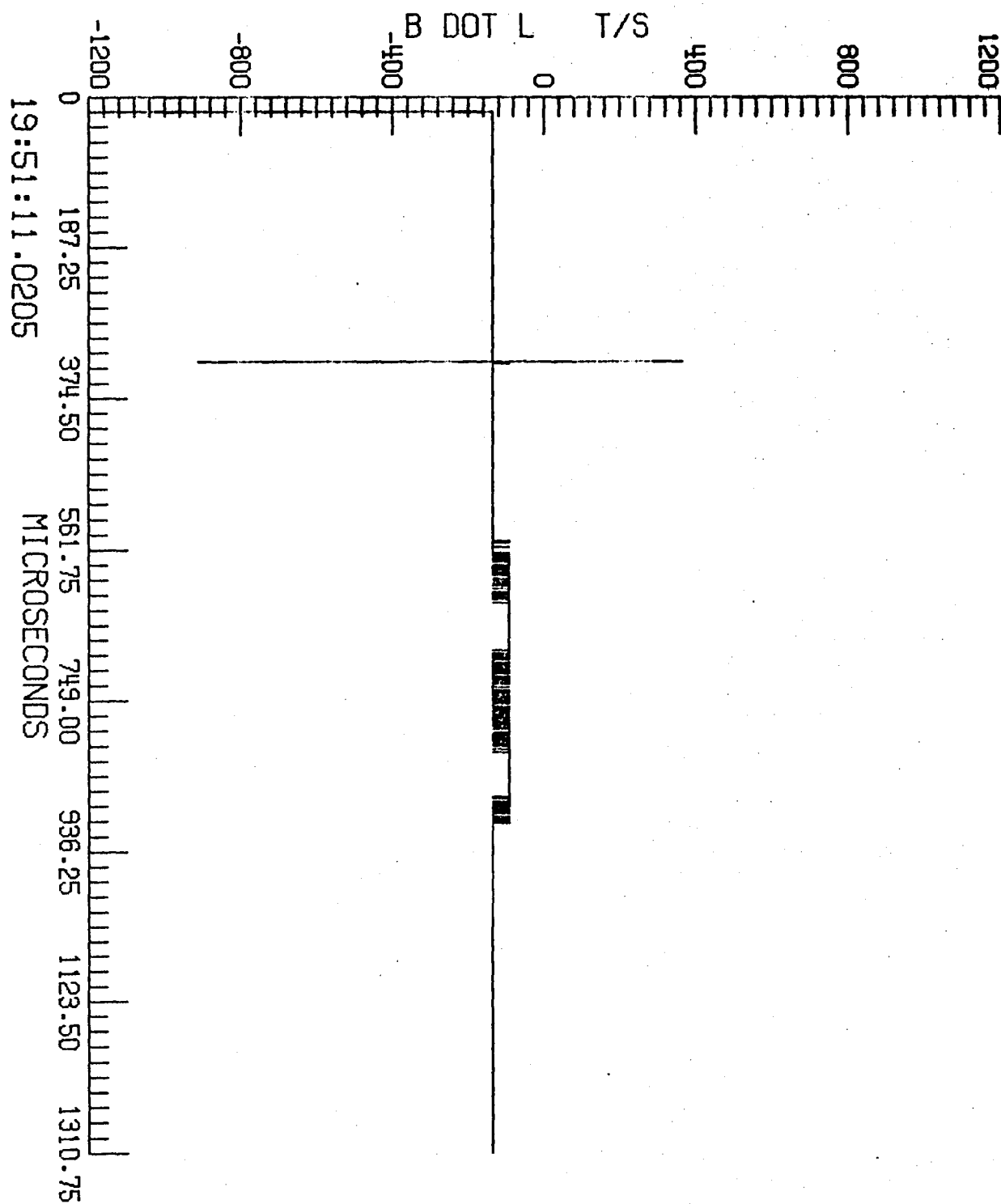
F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 15 N-010

TEST NO. 83



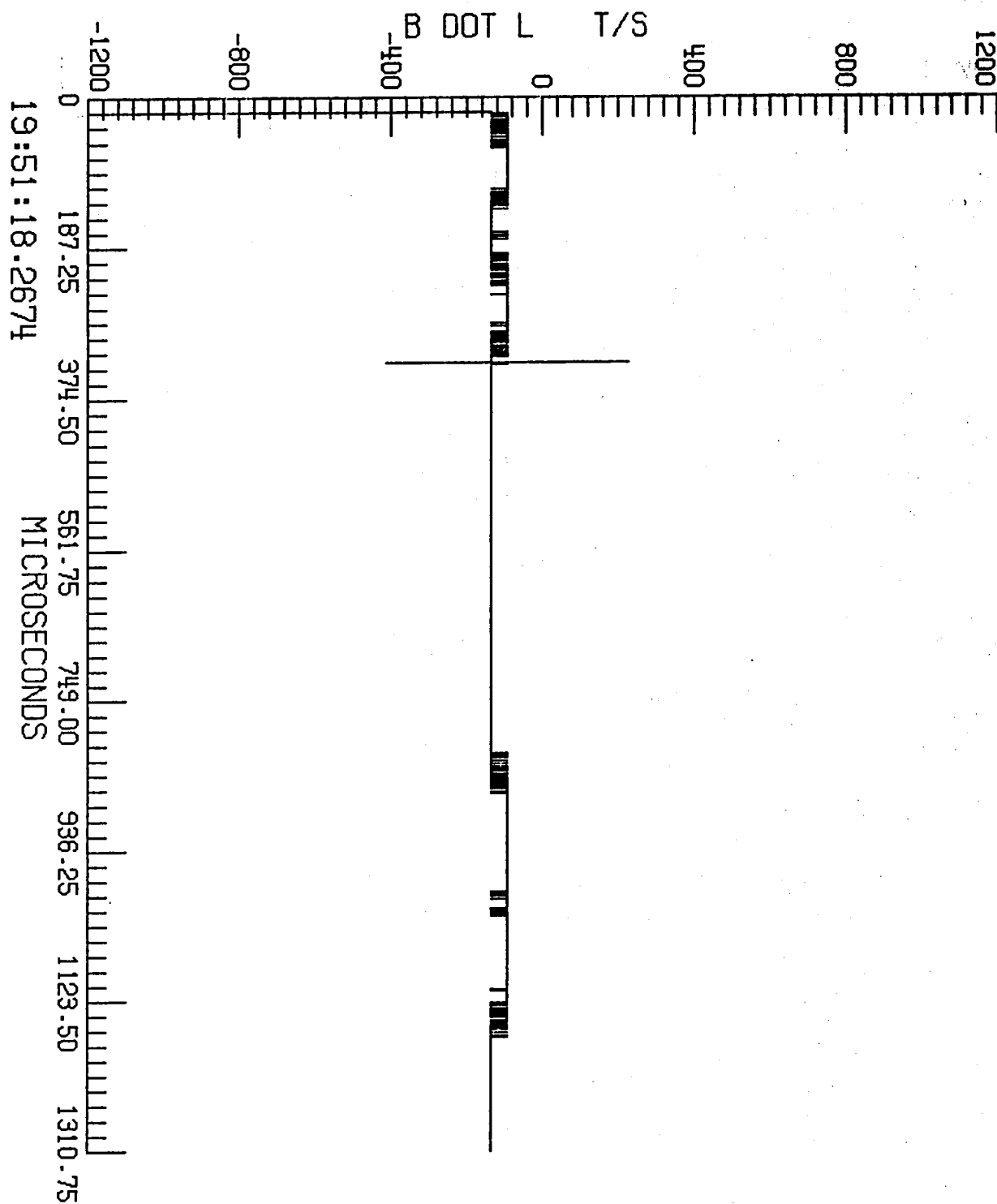
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 15 N-010

TEST NO. 83.



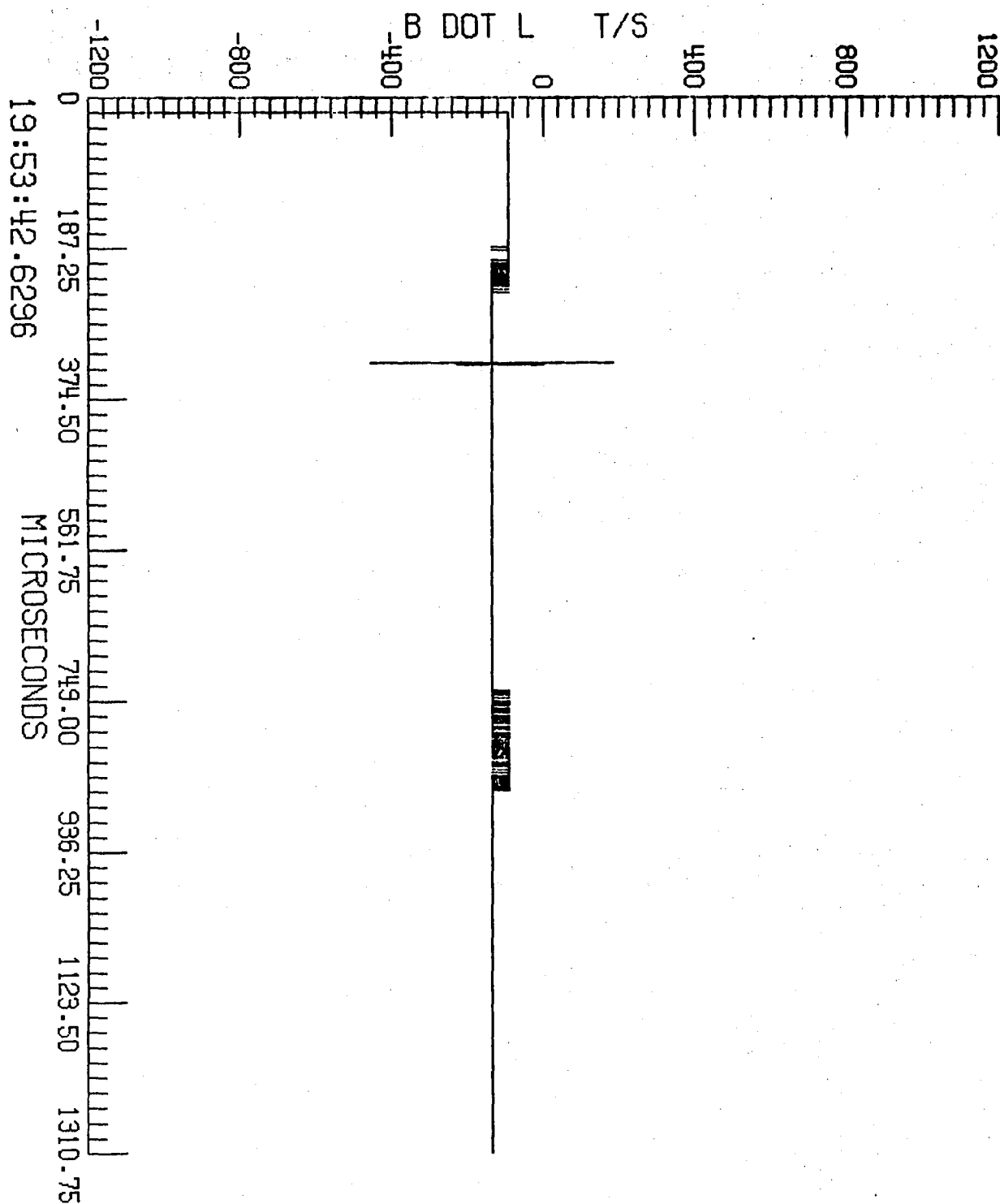
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 16 N-011

TEST NO. 83-



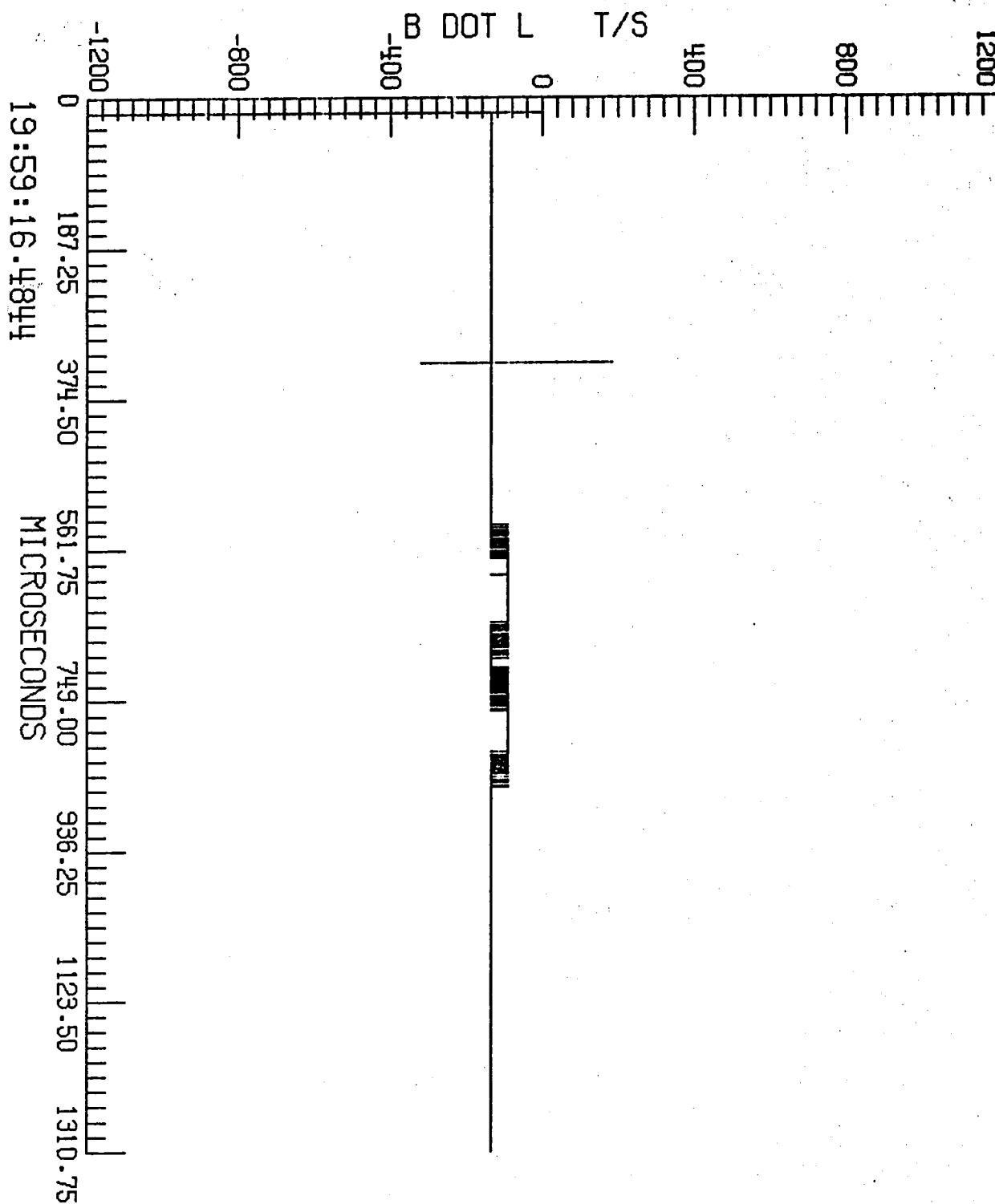
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 17 N-012

TEST NO. 83-



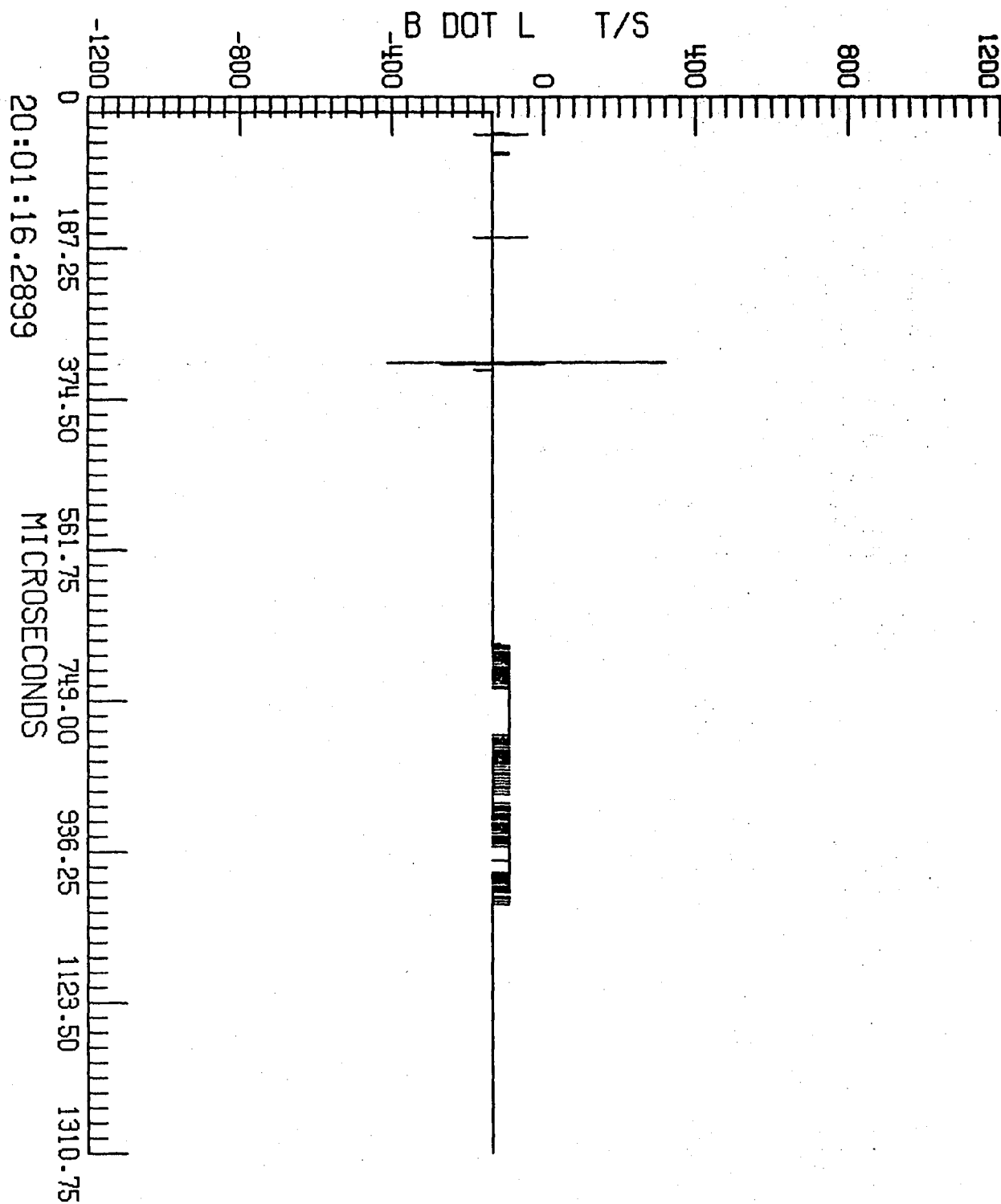
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 18 N-013

TEST NO. 83



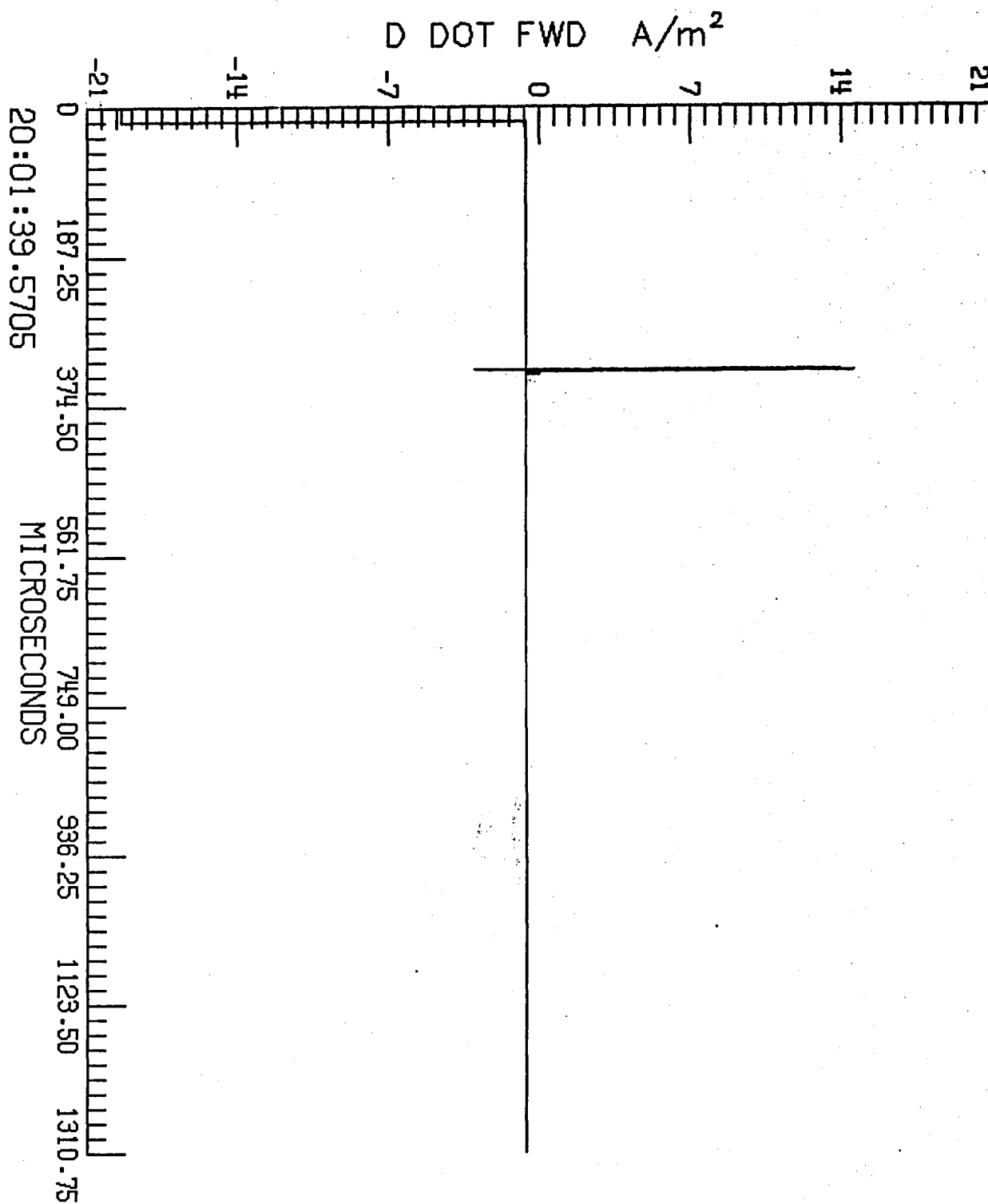
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 19 N-014

TEST NO. 83-



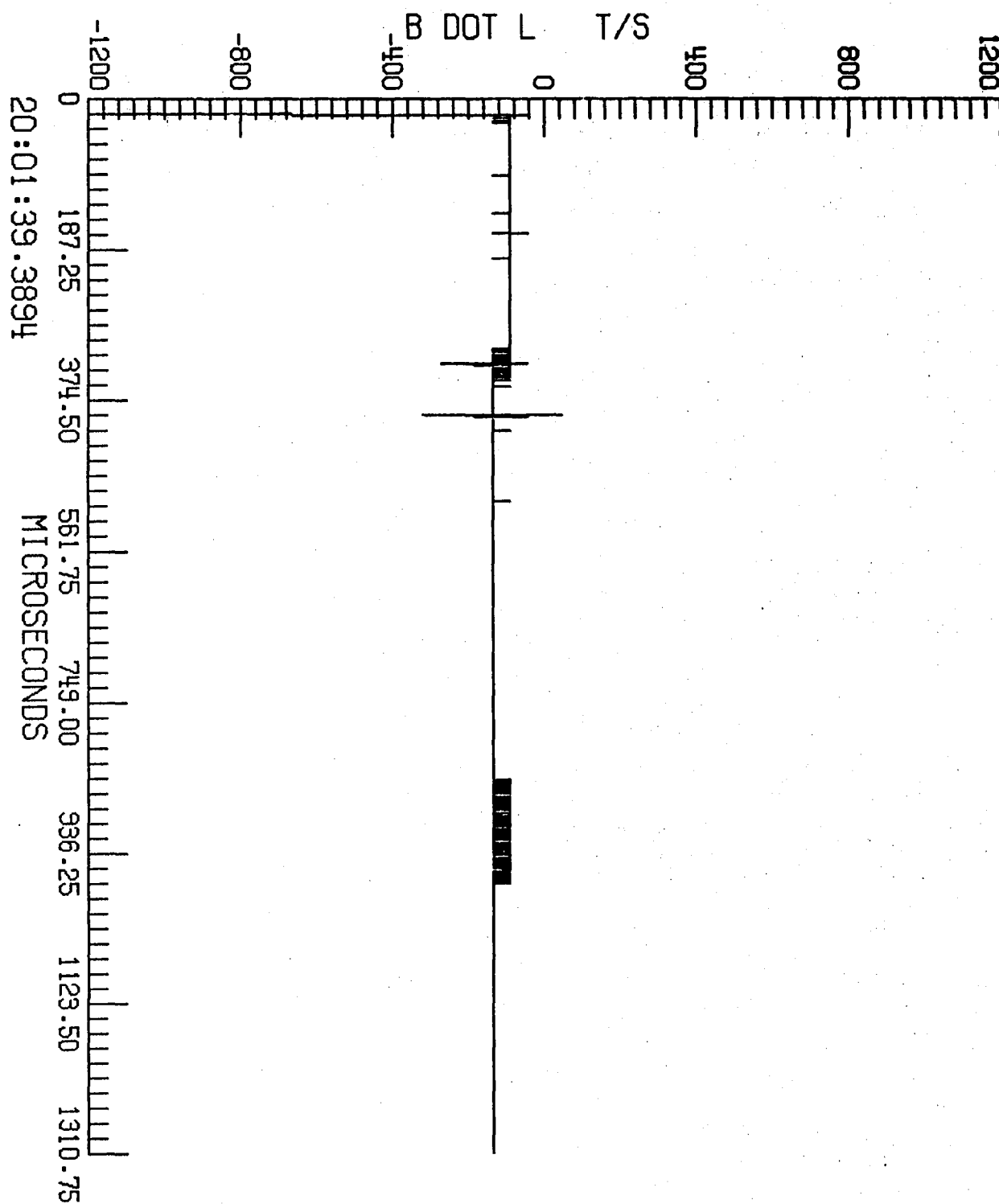
F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 20 S-010

TEST NO. 83



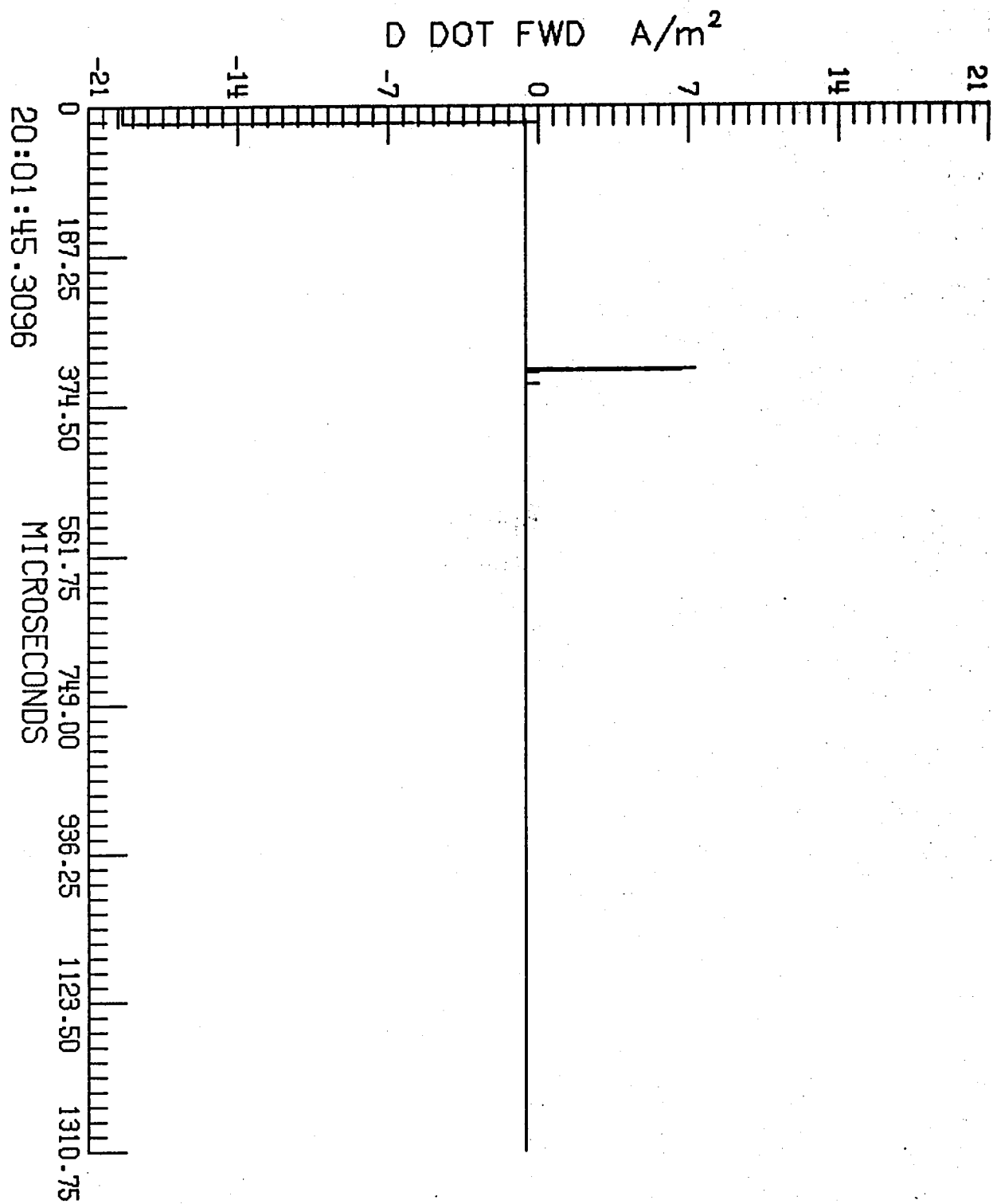
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 20 S-010

TEST NO. 83-



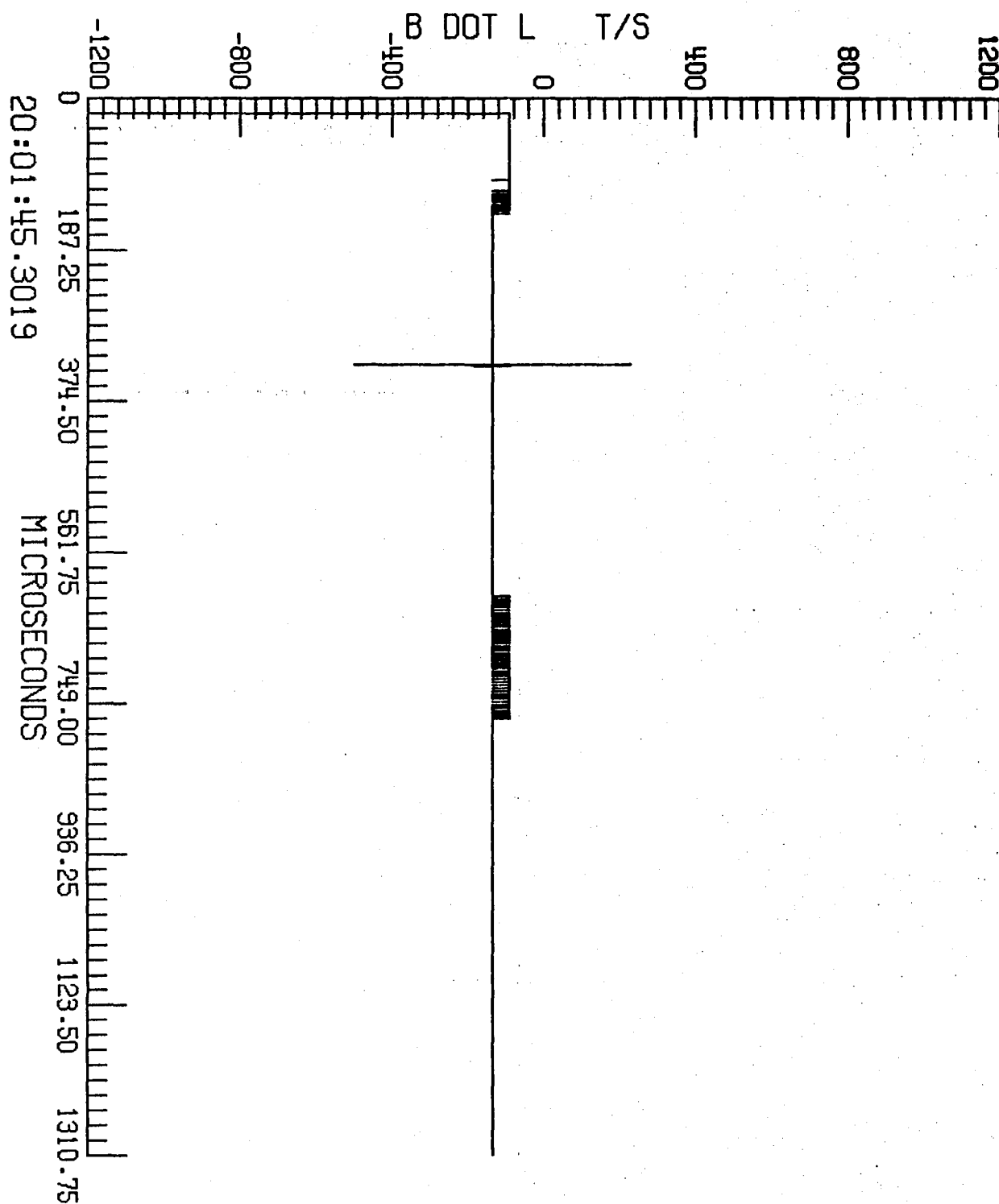
F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 21 S-011

TEST NO. 83



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 21 S-011

TEST NO. 83-

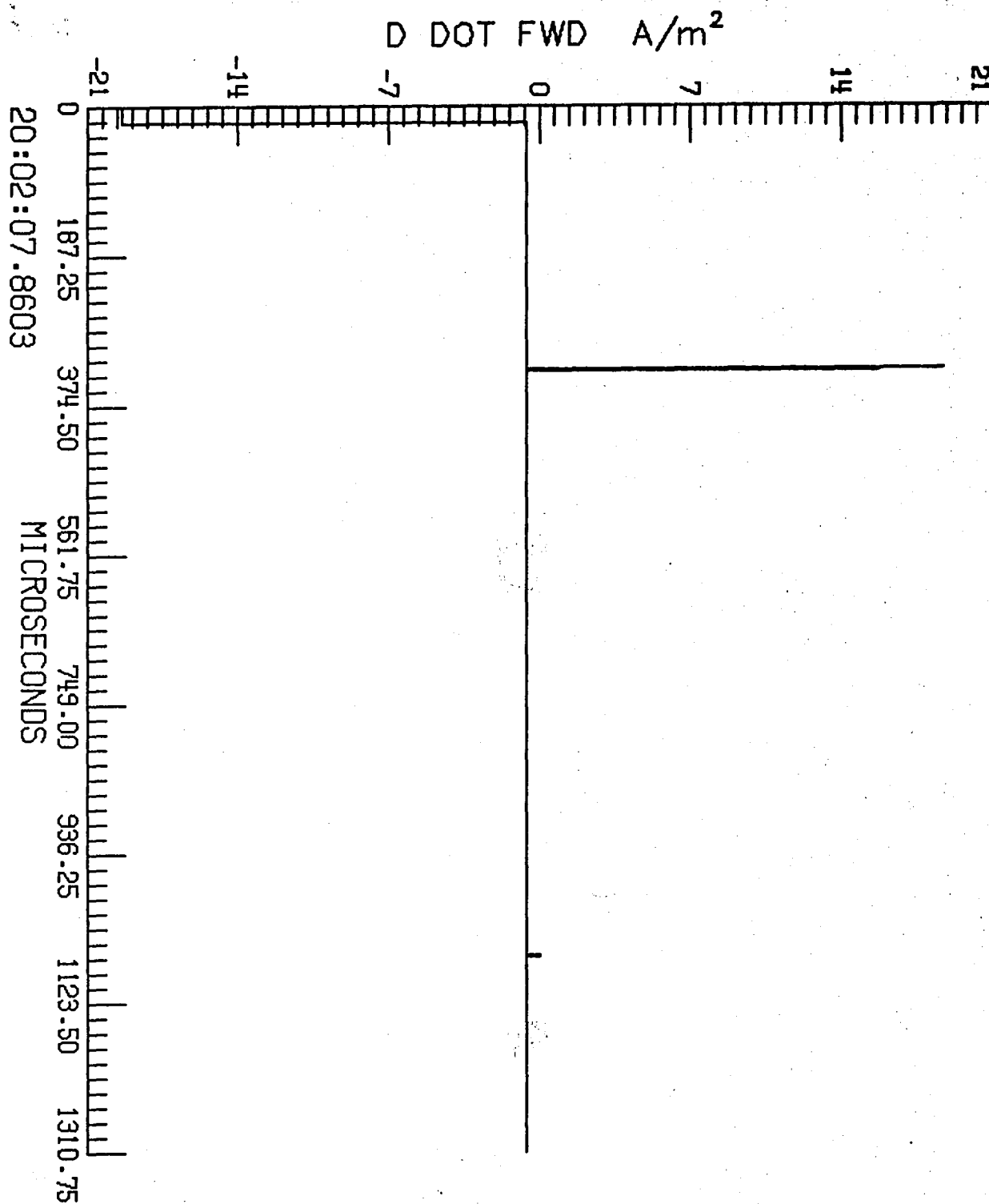


F106 LIGHTNING/TK 8/M.THOMAS

TEST NO. 83

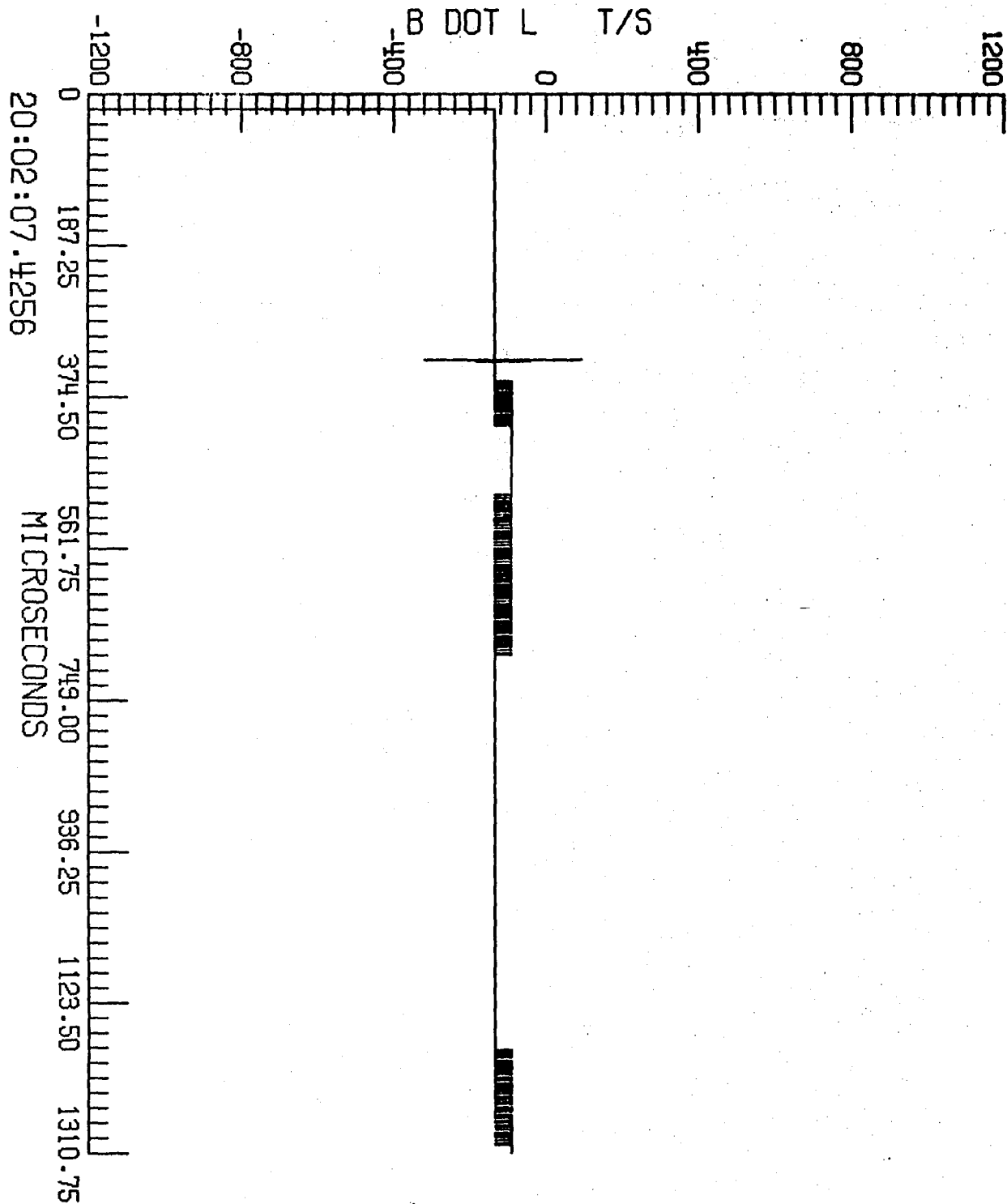
RUN NO. 22

S-012



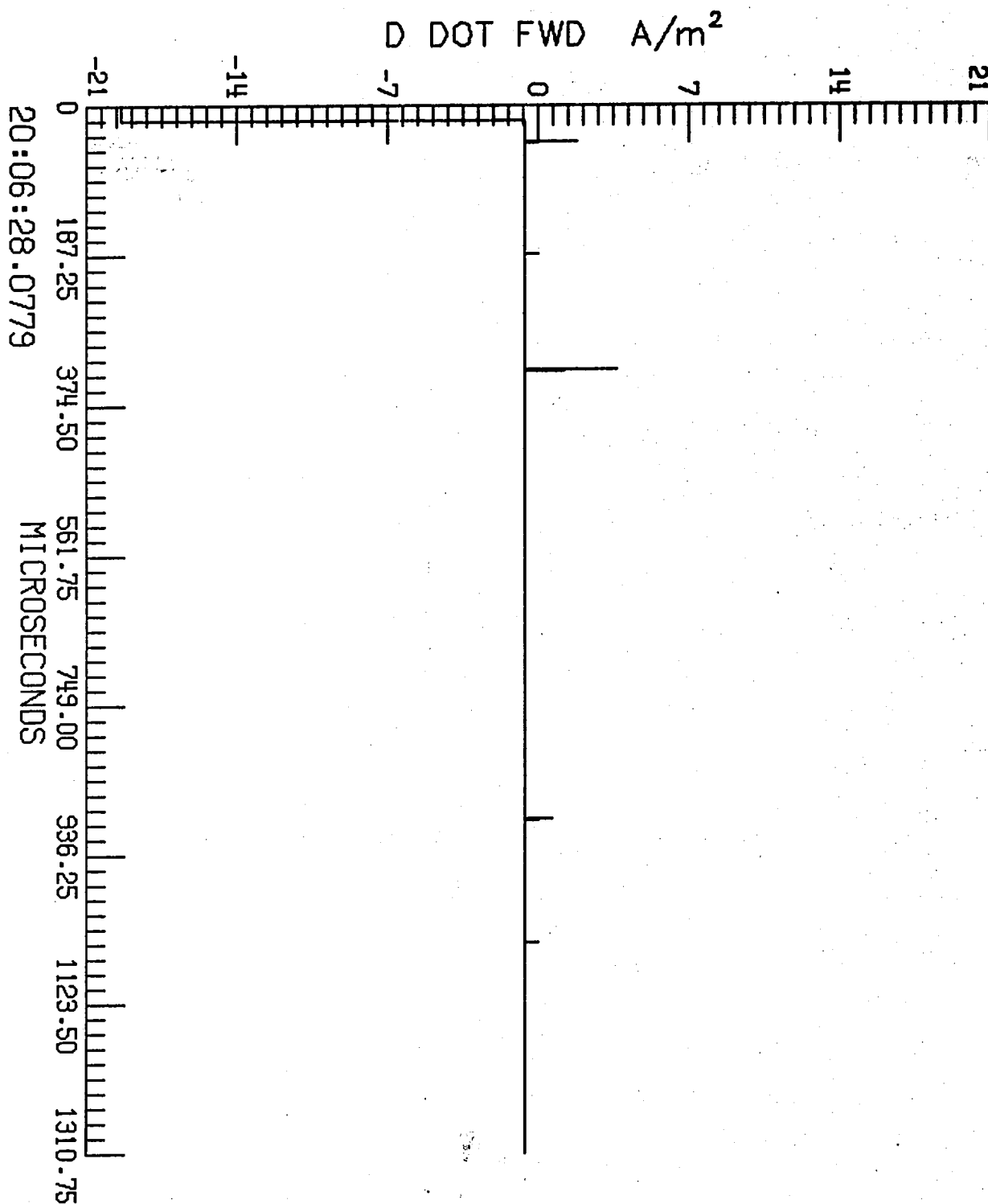
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 22 S-012

TEST NO. 83.



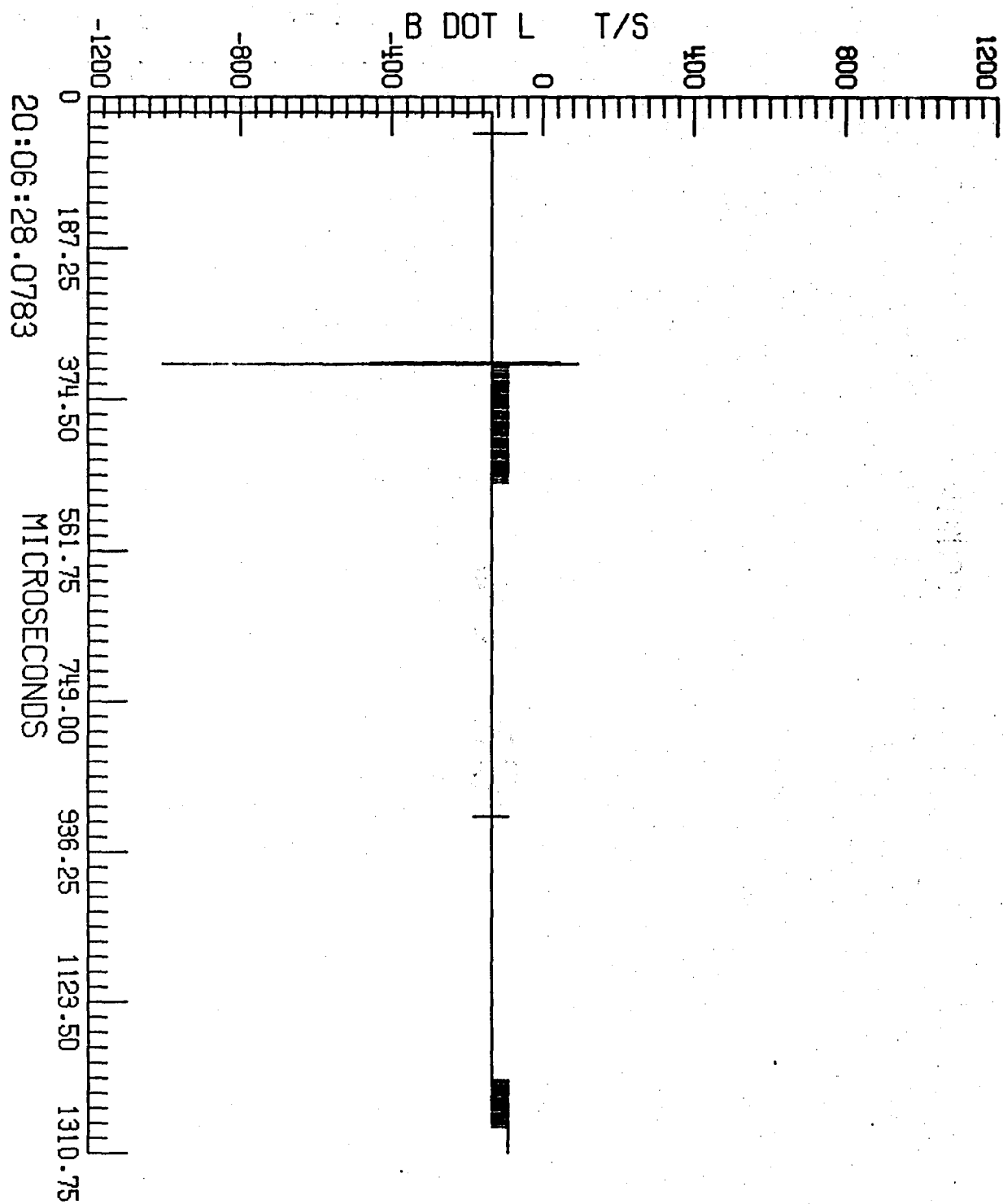
F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 23 S-013

TEST NO. 83.



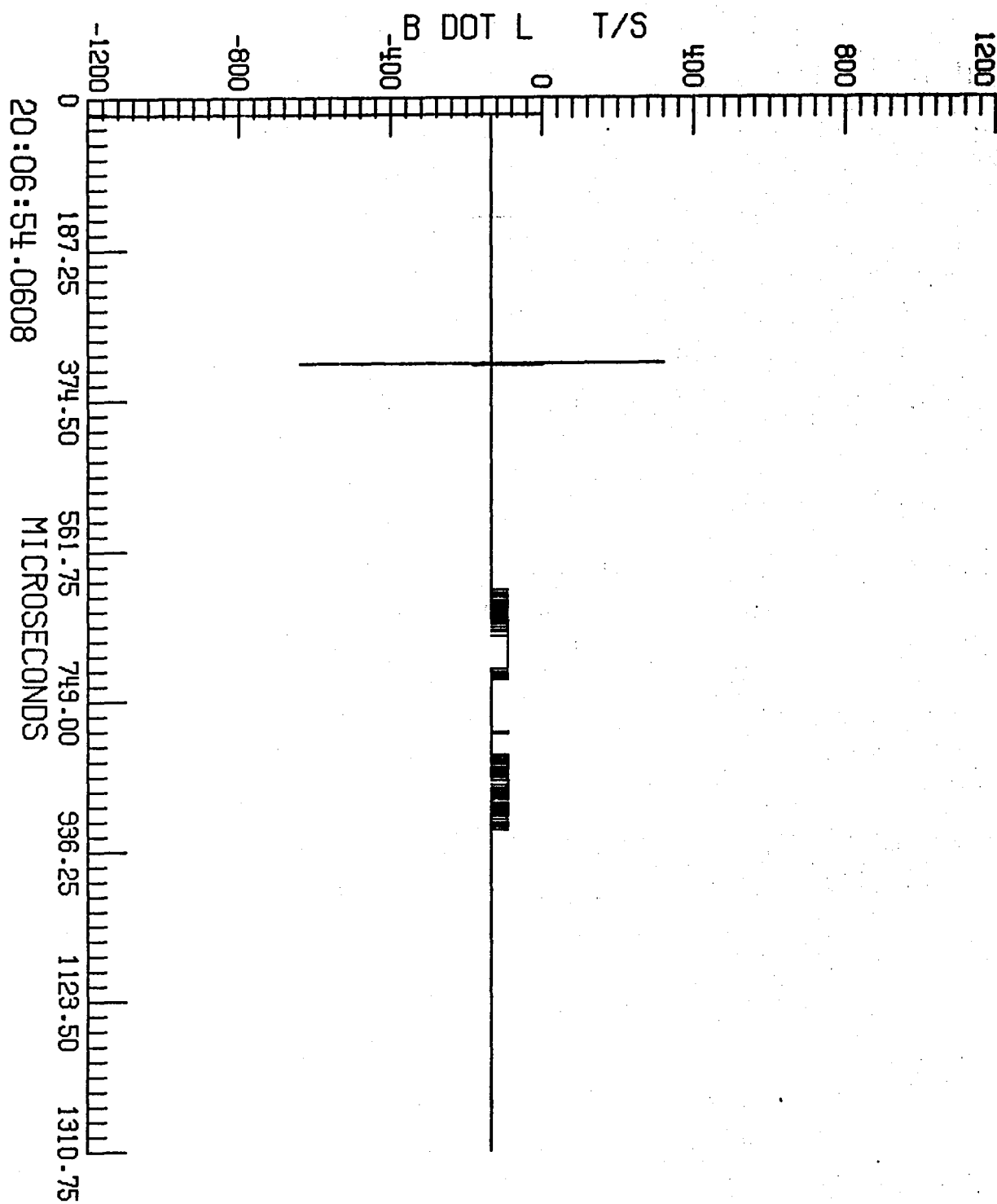
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 23 S-013

TEST NO. 83-



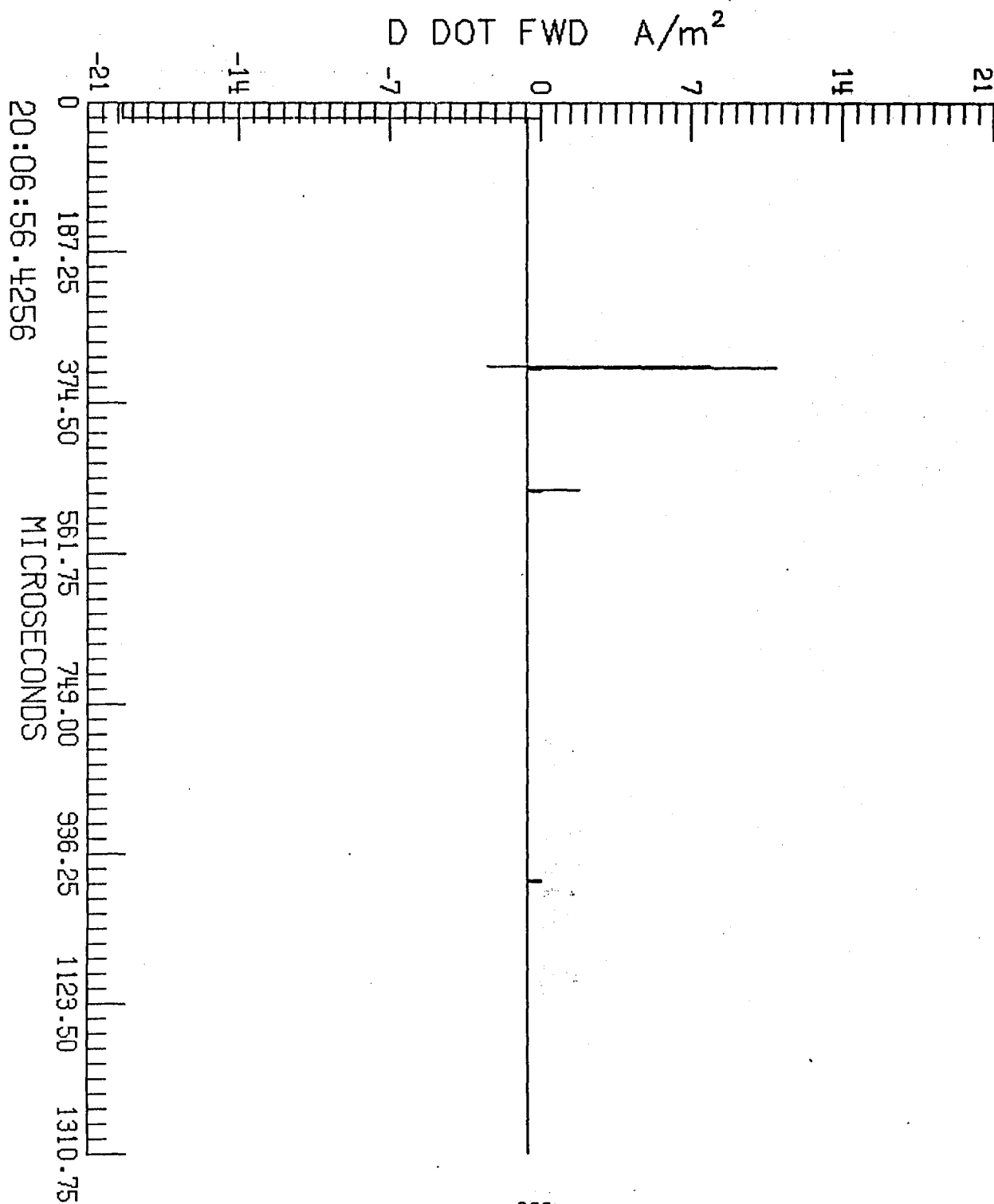
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 24 N-015

TEST NO. 83-



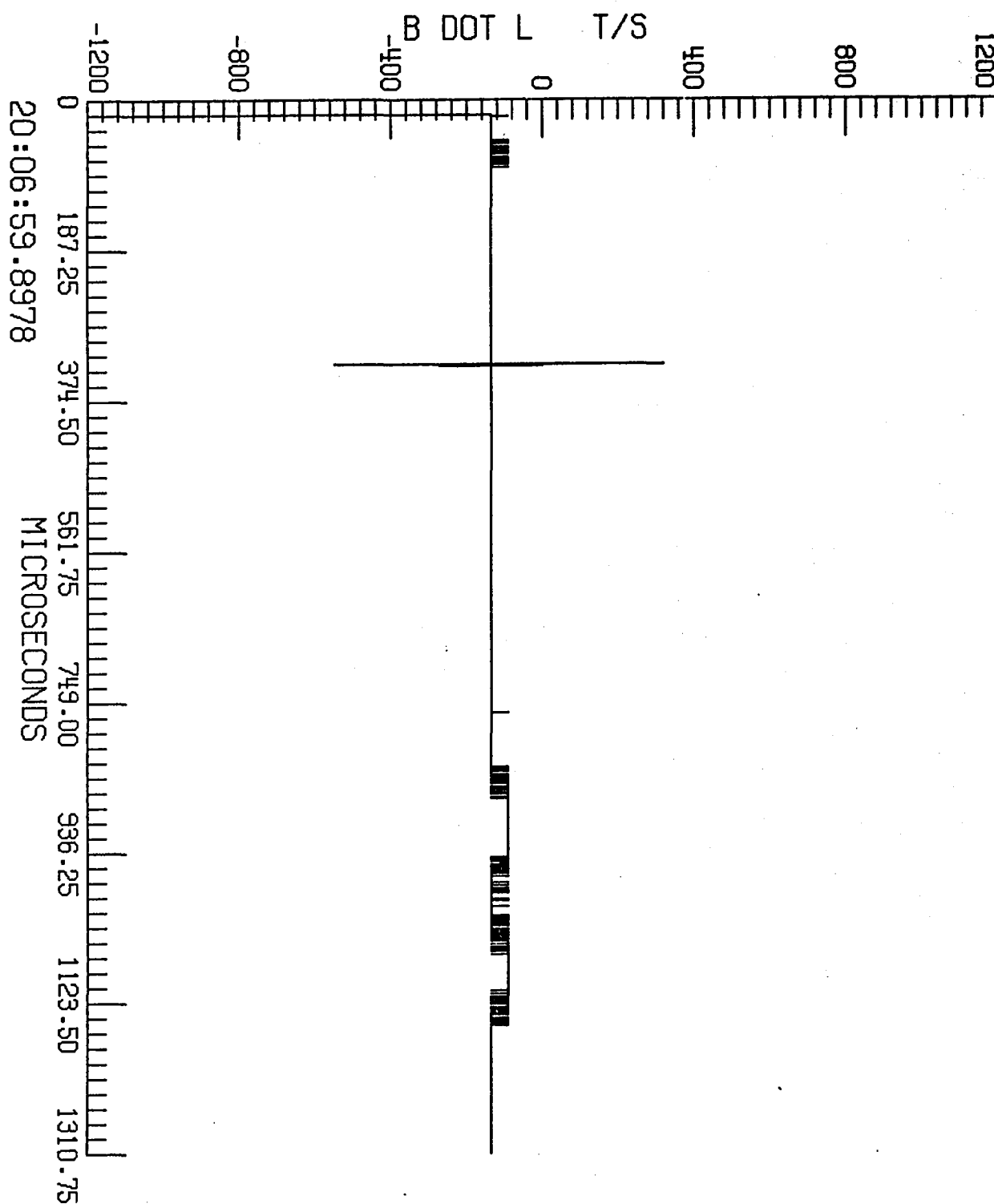
F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 25 N-016

TEST NO. 83-



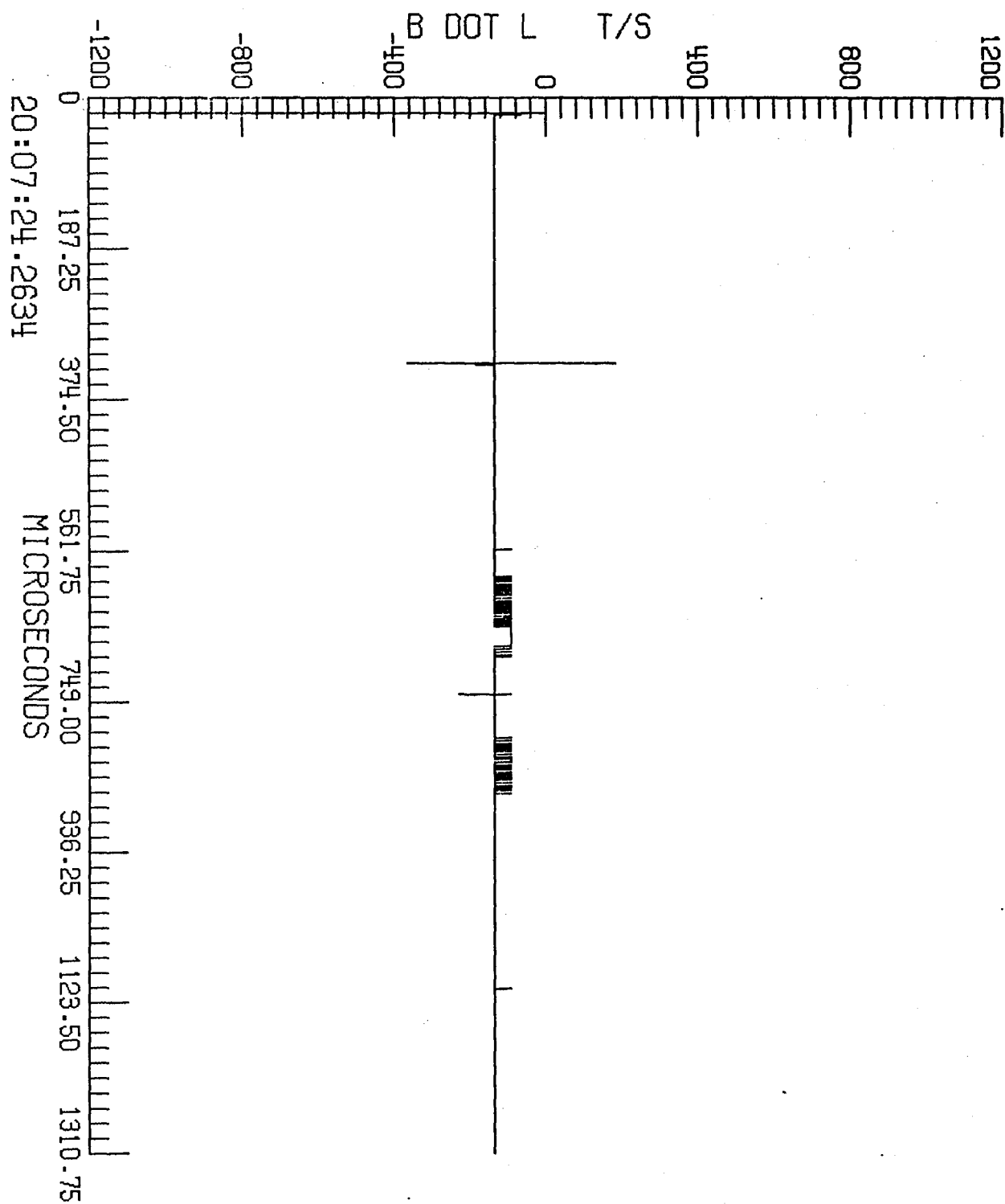
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 26 N-017

TEST NO. 83-



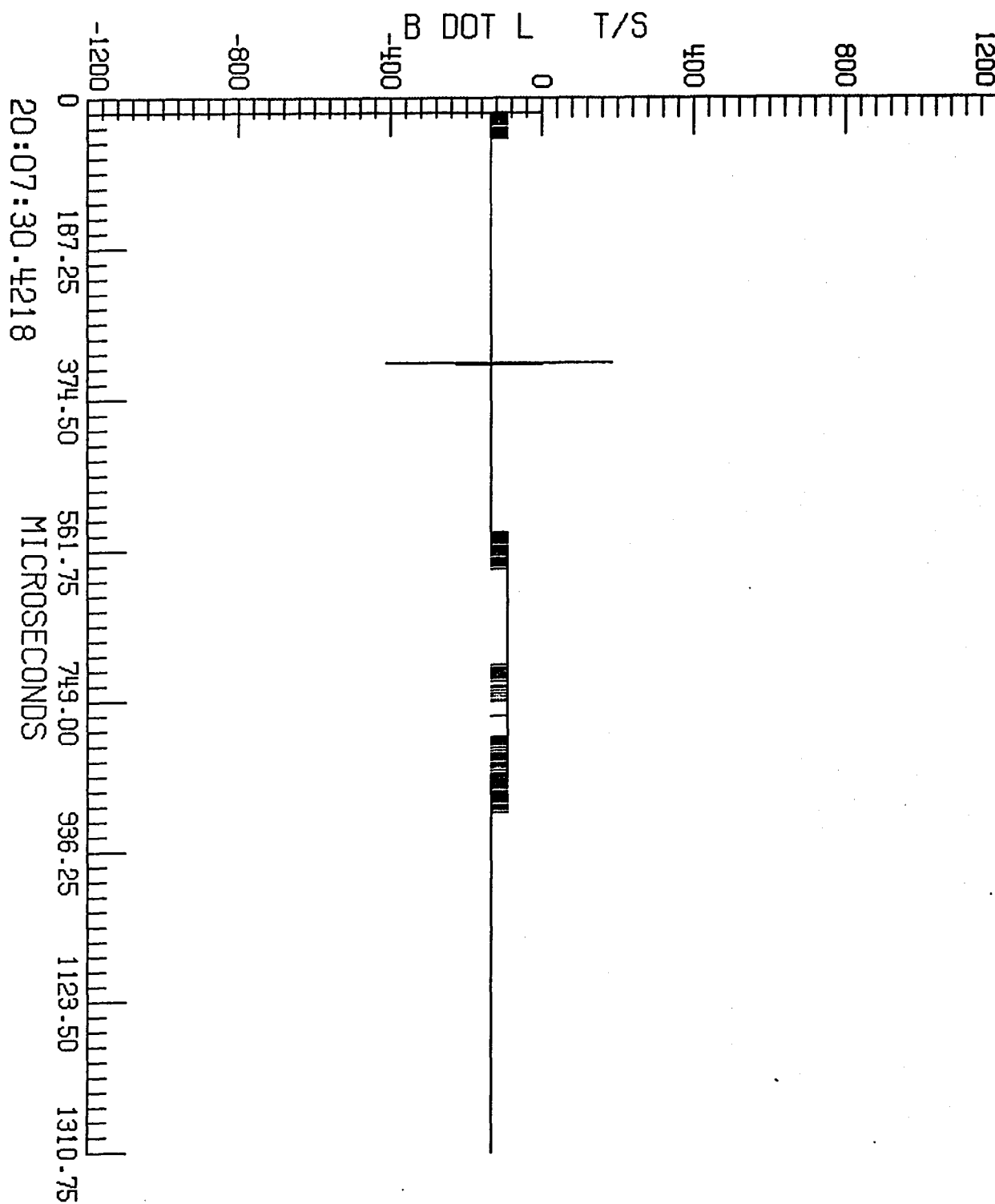
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 27 N-018

TEST NO. 83-



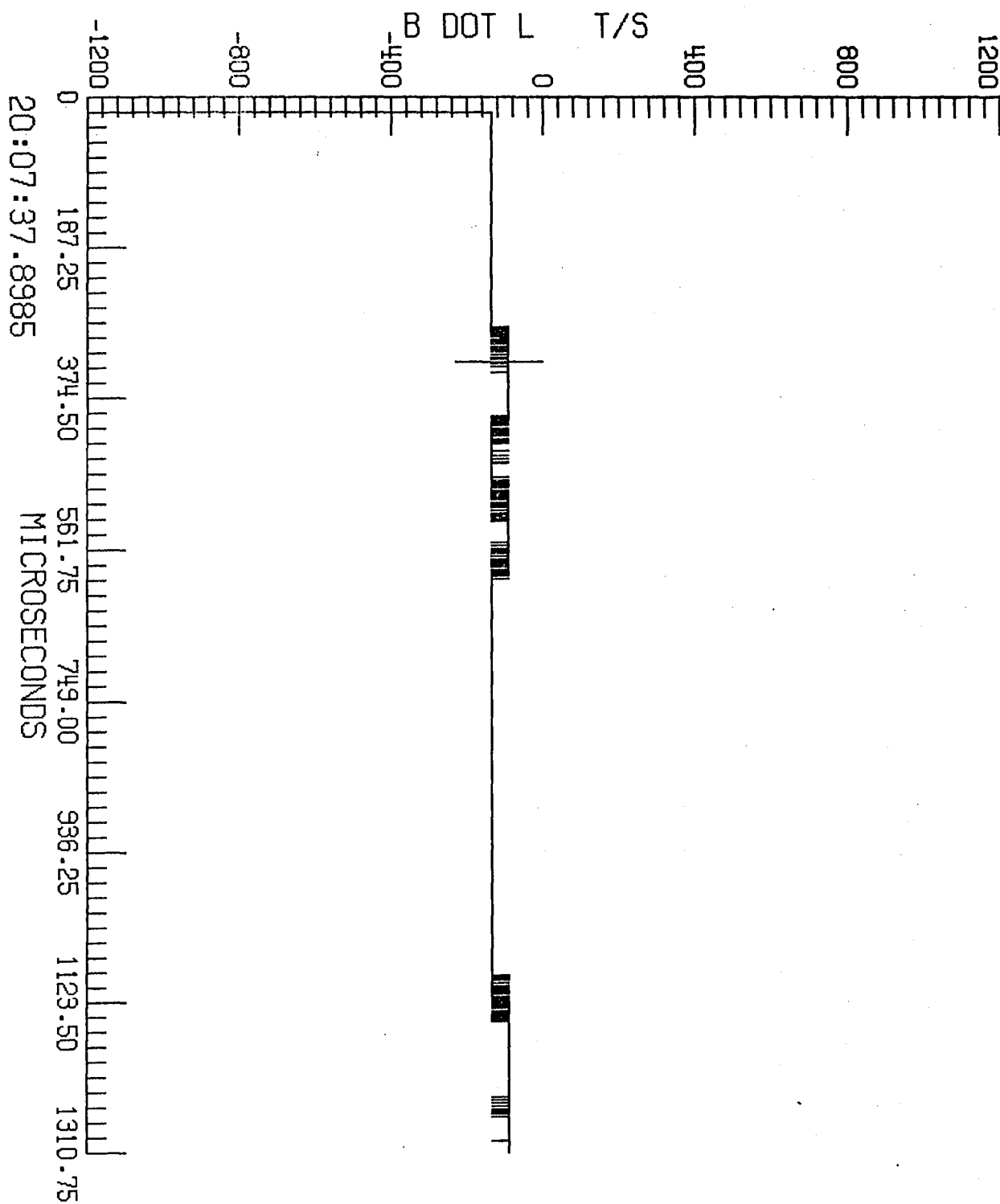
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 28 S-015

TEST NO. 83-



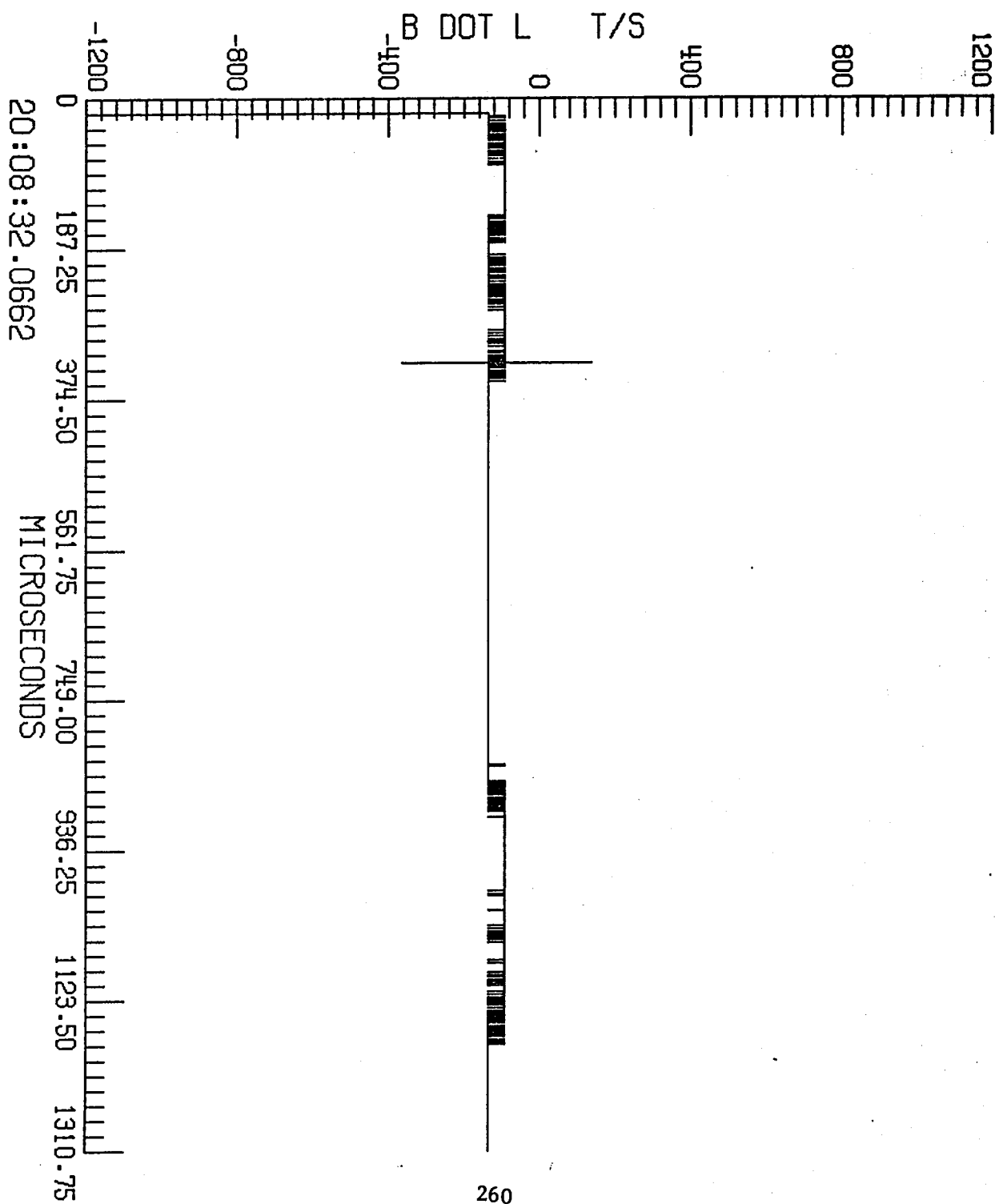
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 29 N-019

TEST NO. 83



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 30 N-020

TEST NO. 83

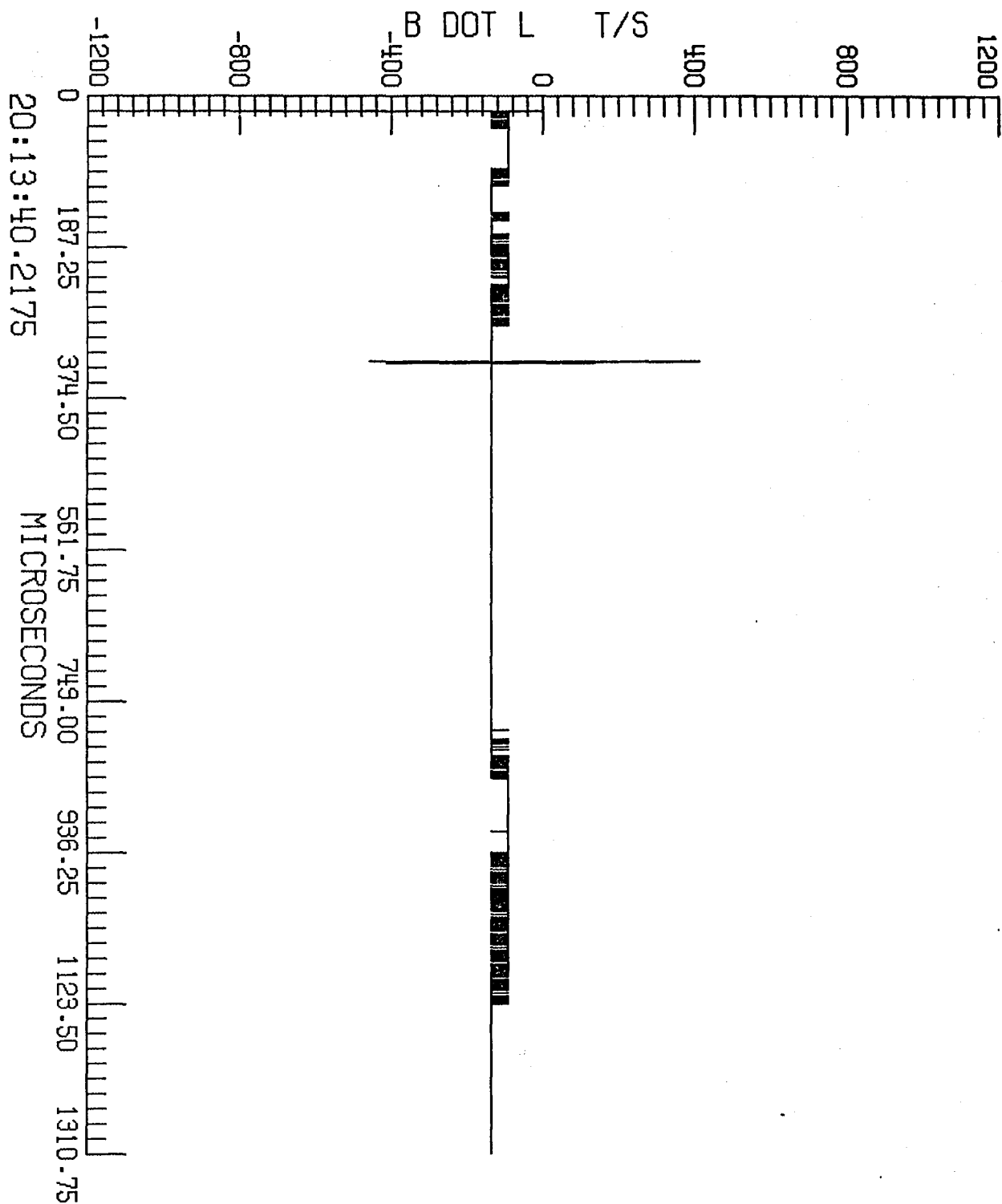


F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83.

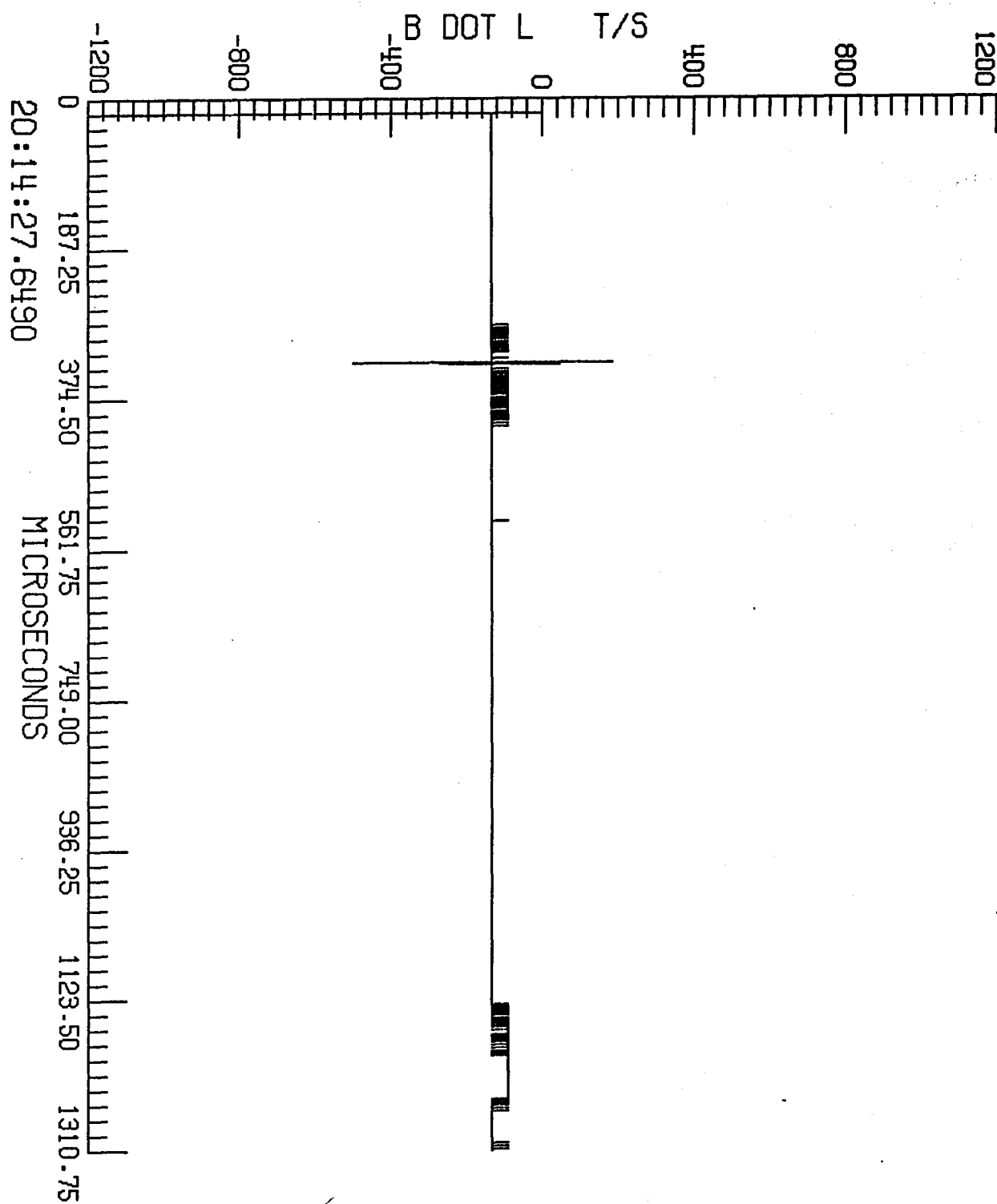
RUN NO. 31

S-016



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 32 N-021

TEST NO. 83

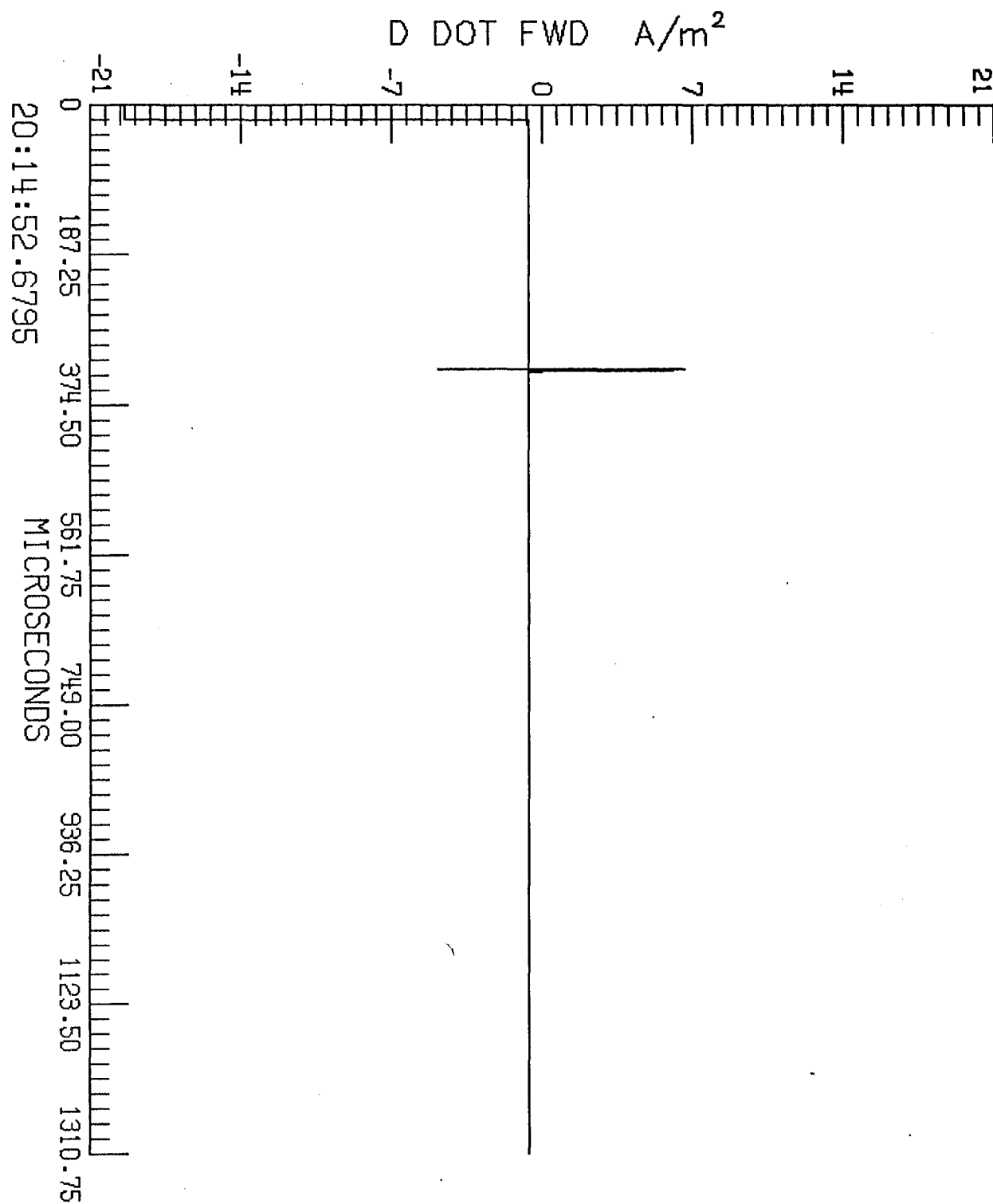


F106 LIGHTNING/TK 8/M.THOMAS

TEST NO. 83-

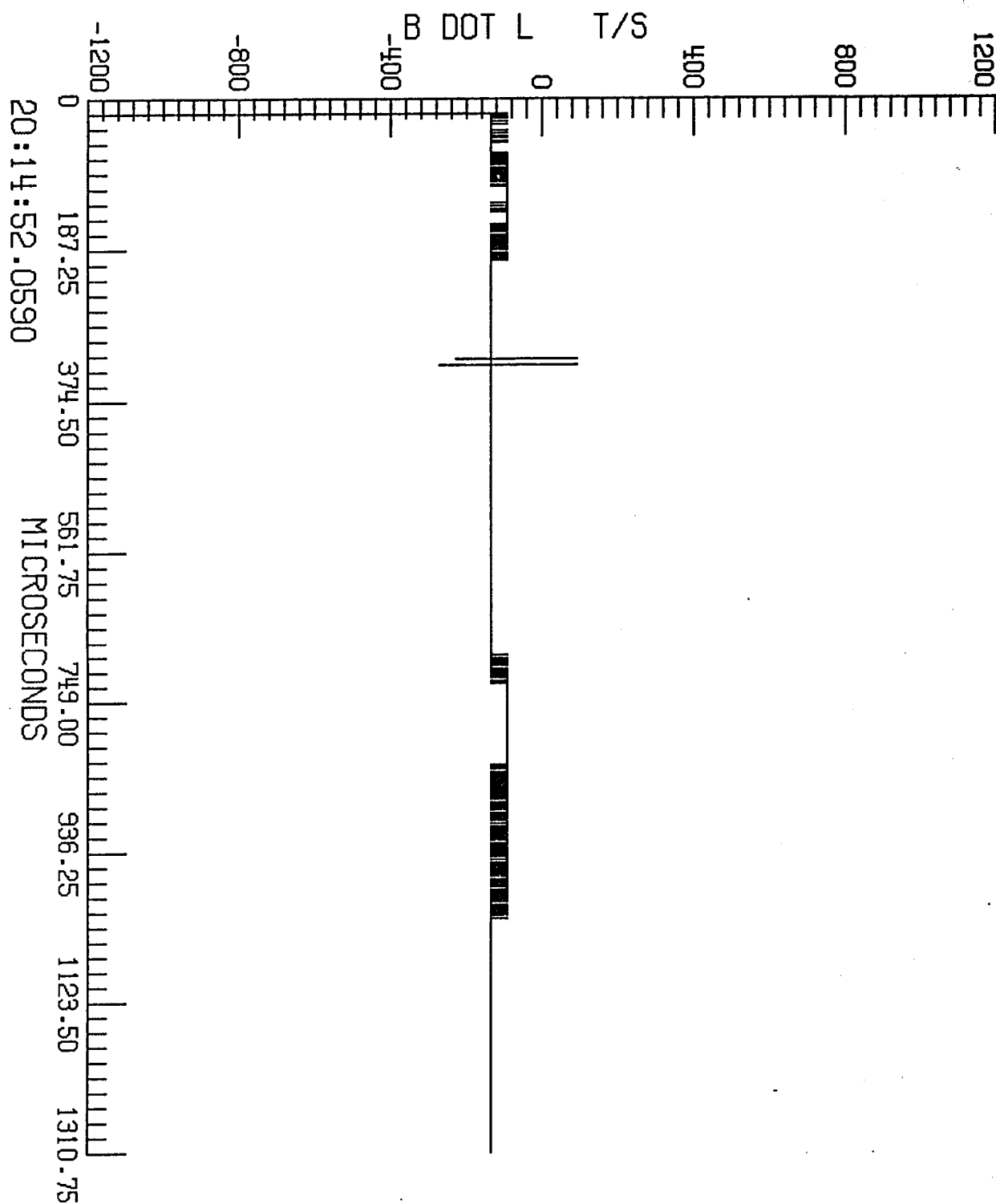
RUN NO. 33

S-017



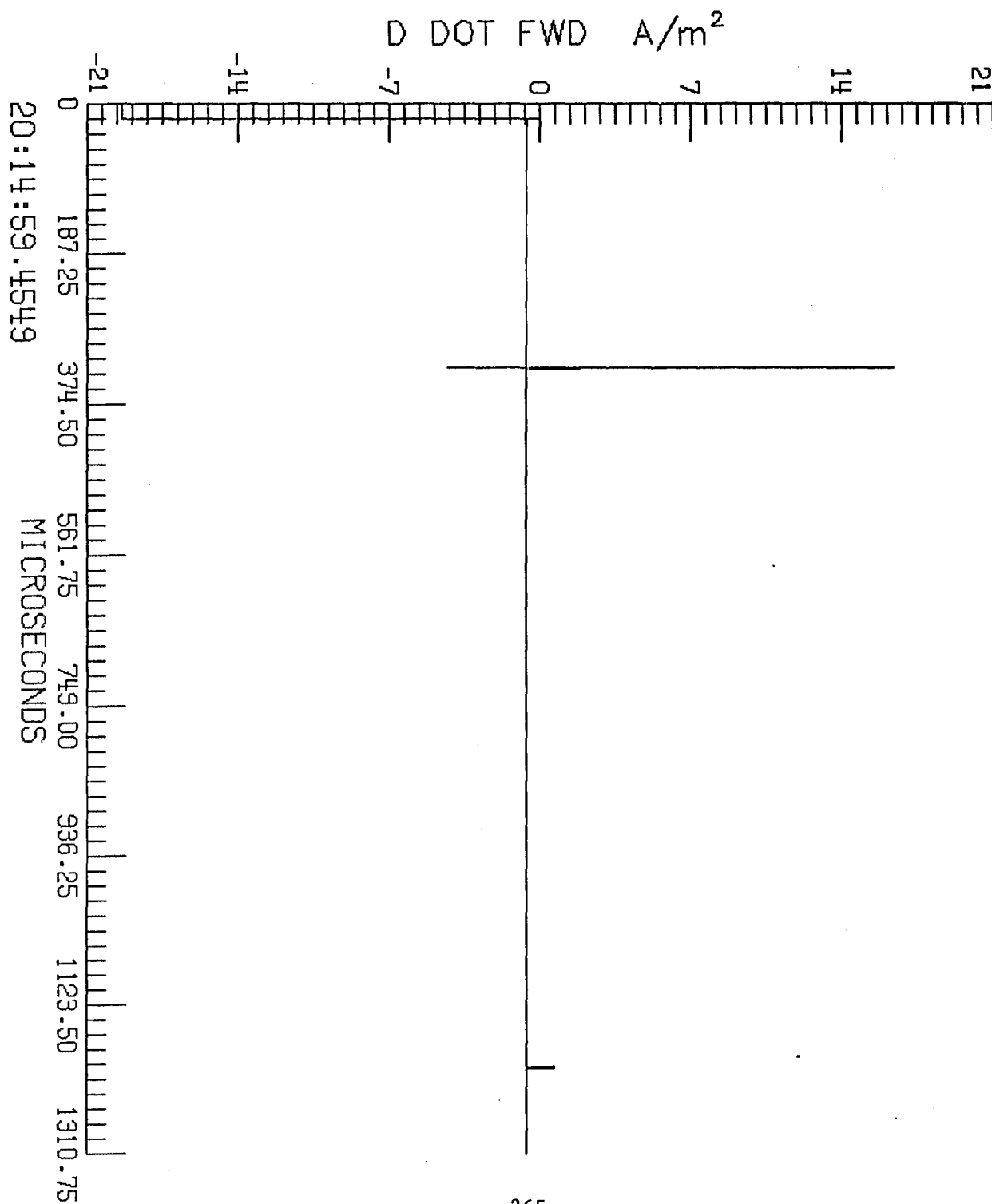
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 33 S-017

TEST NO. 83-



F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 34 S-018

TEST NO. 83-

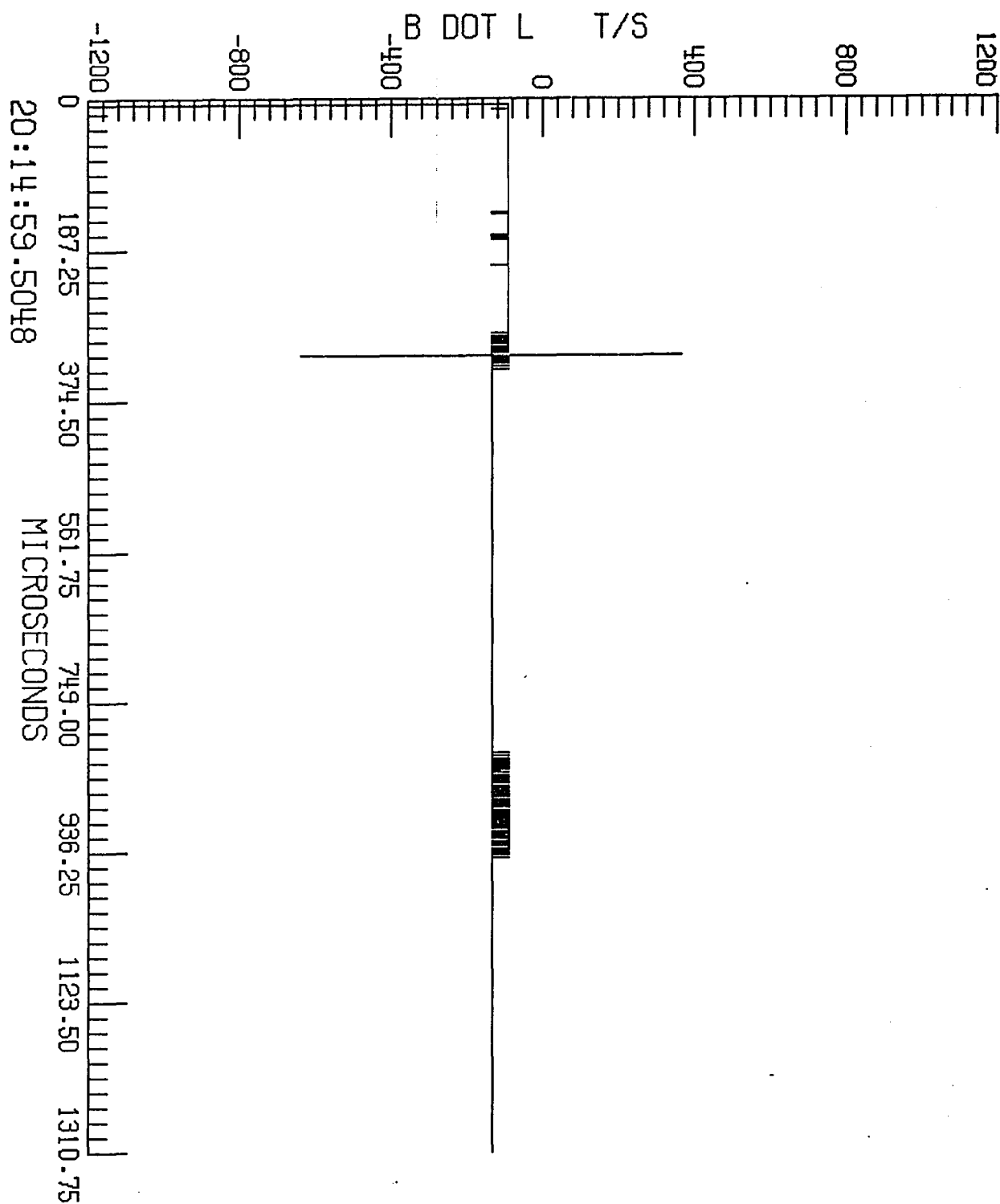


F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83

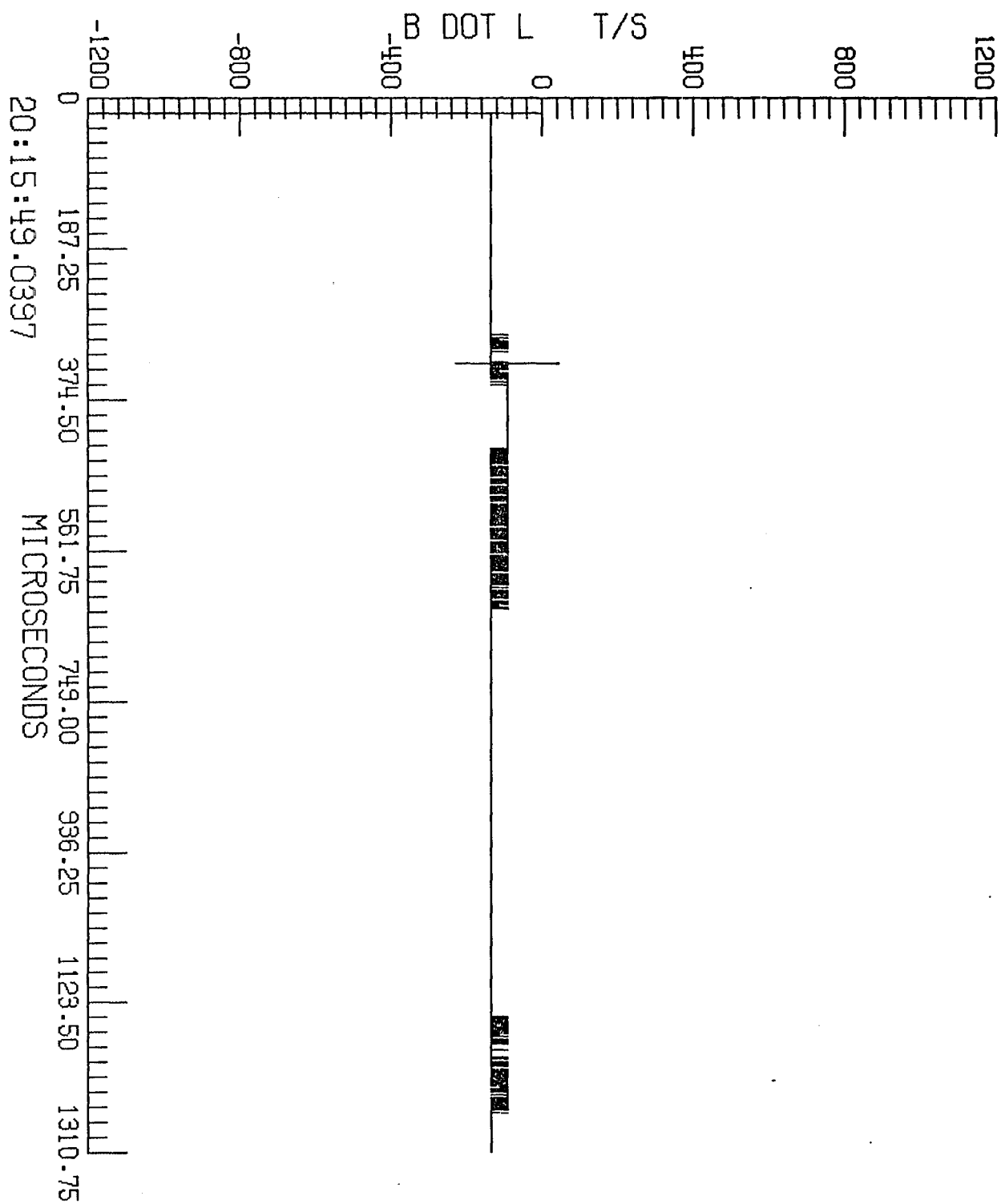
RUN NO. 34

S-018



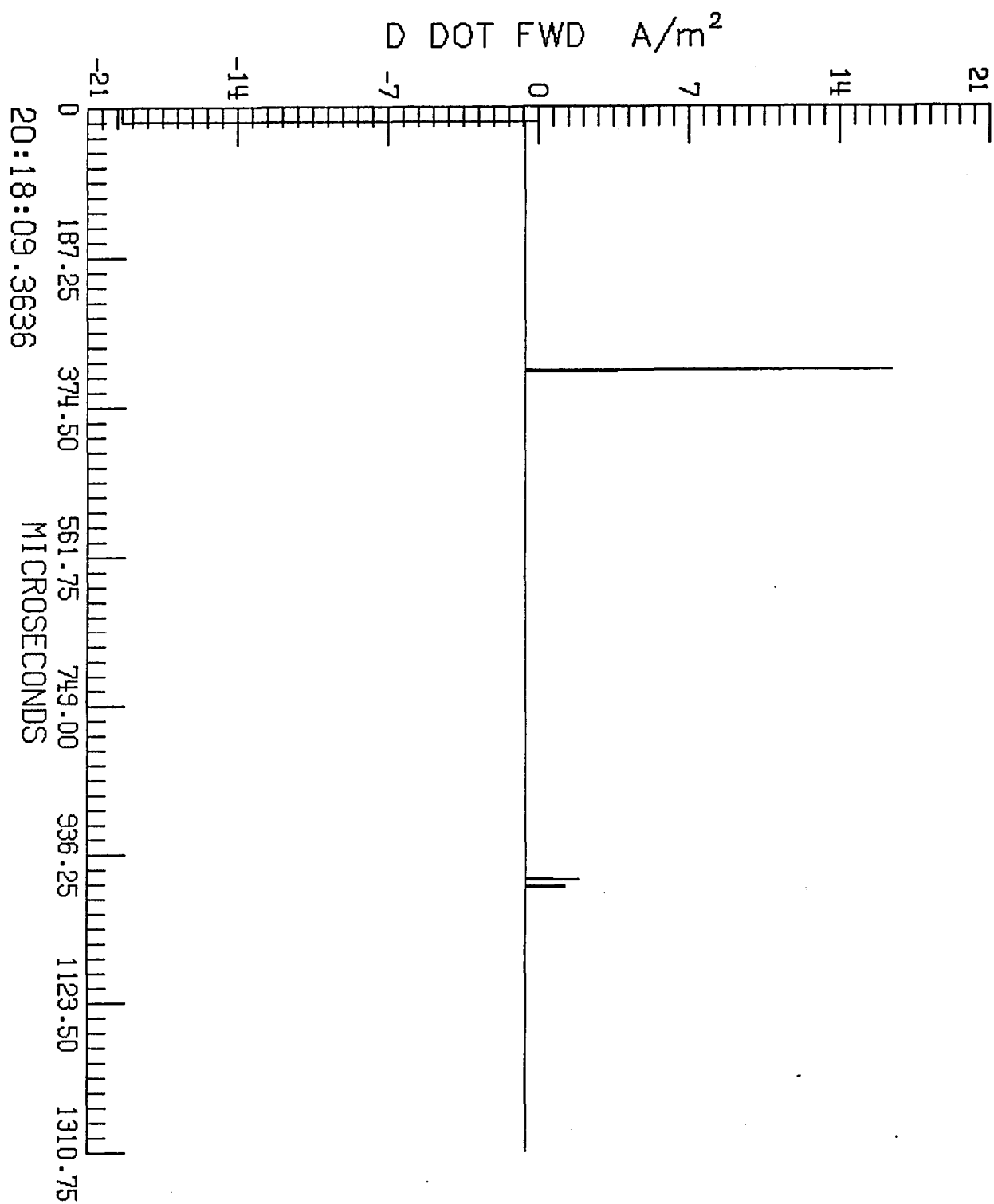
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 35 S-019

TEST NO. 83-



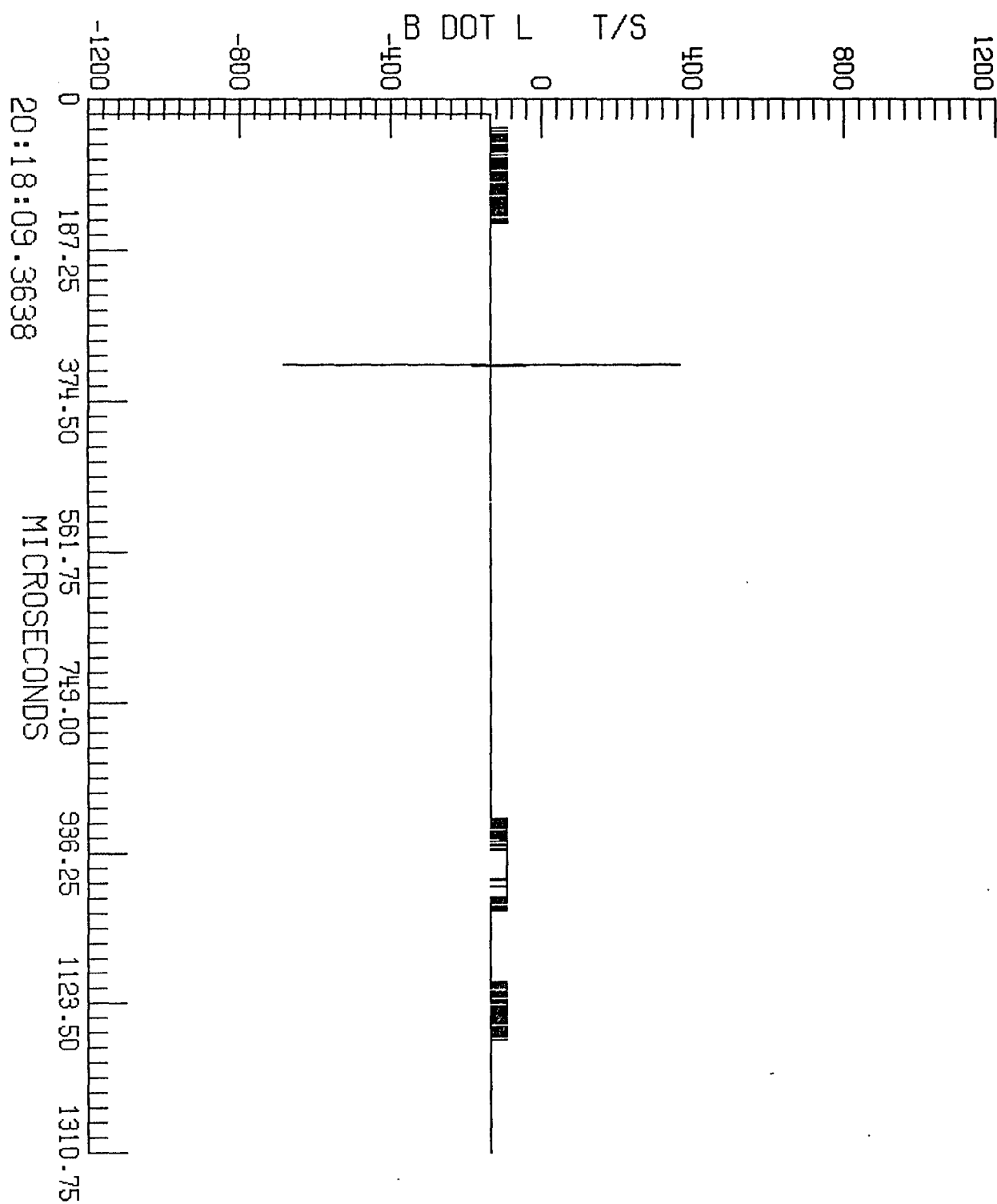
F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 36 S-020

TEST NO. 83-



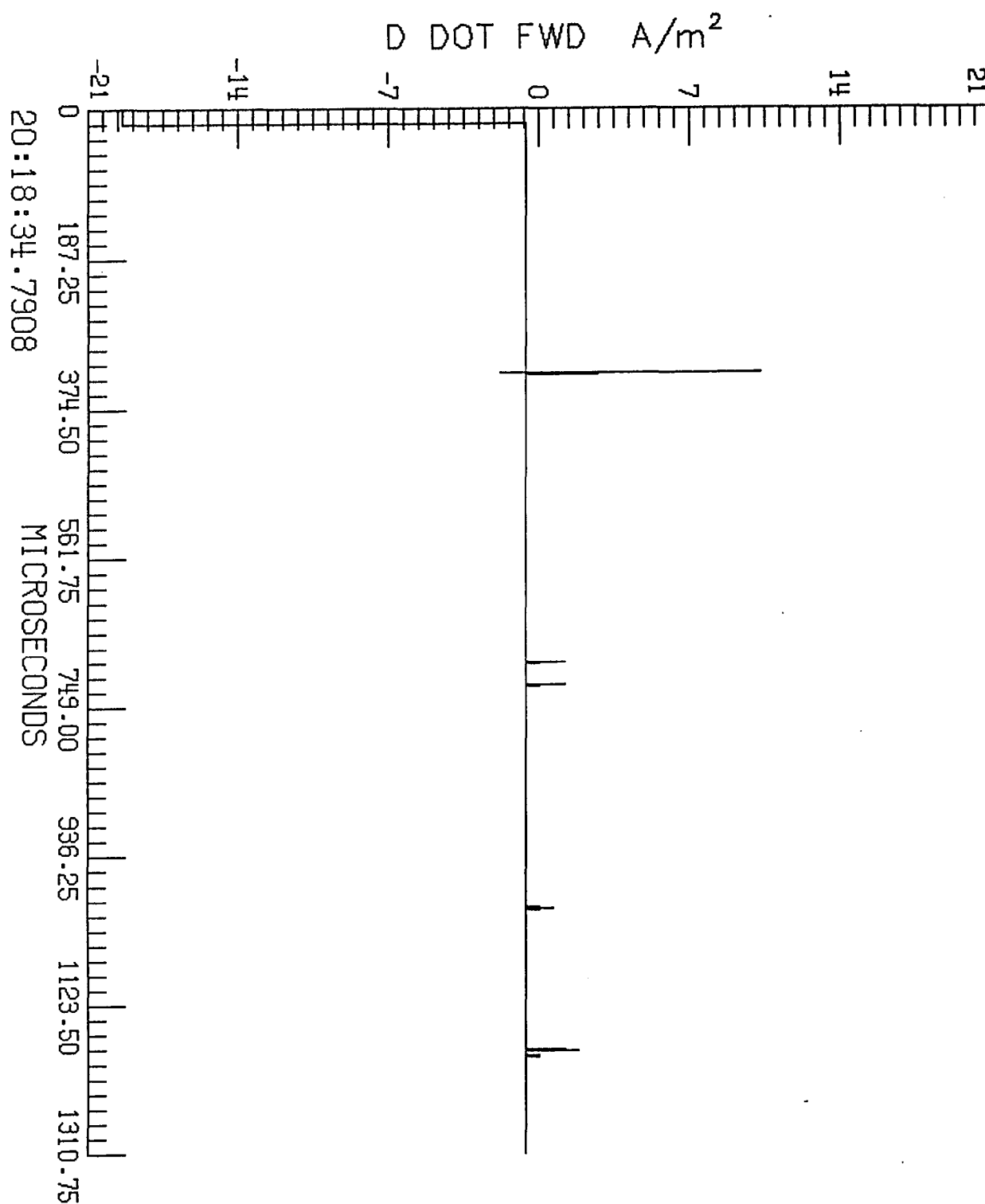
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 36 S-020

TEST NO. 83



F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 37 N-022

TEST NO. 83

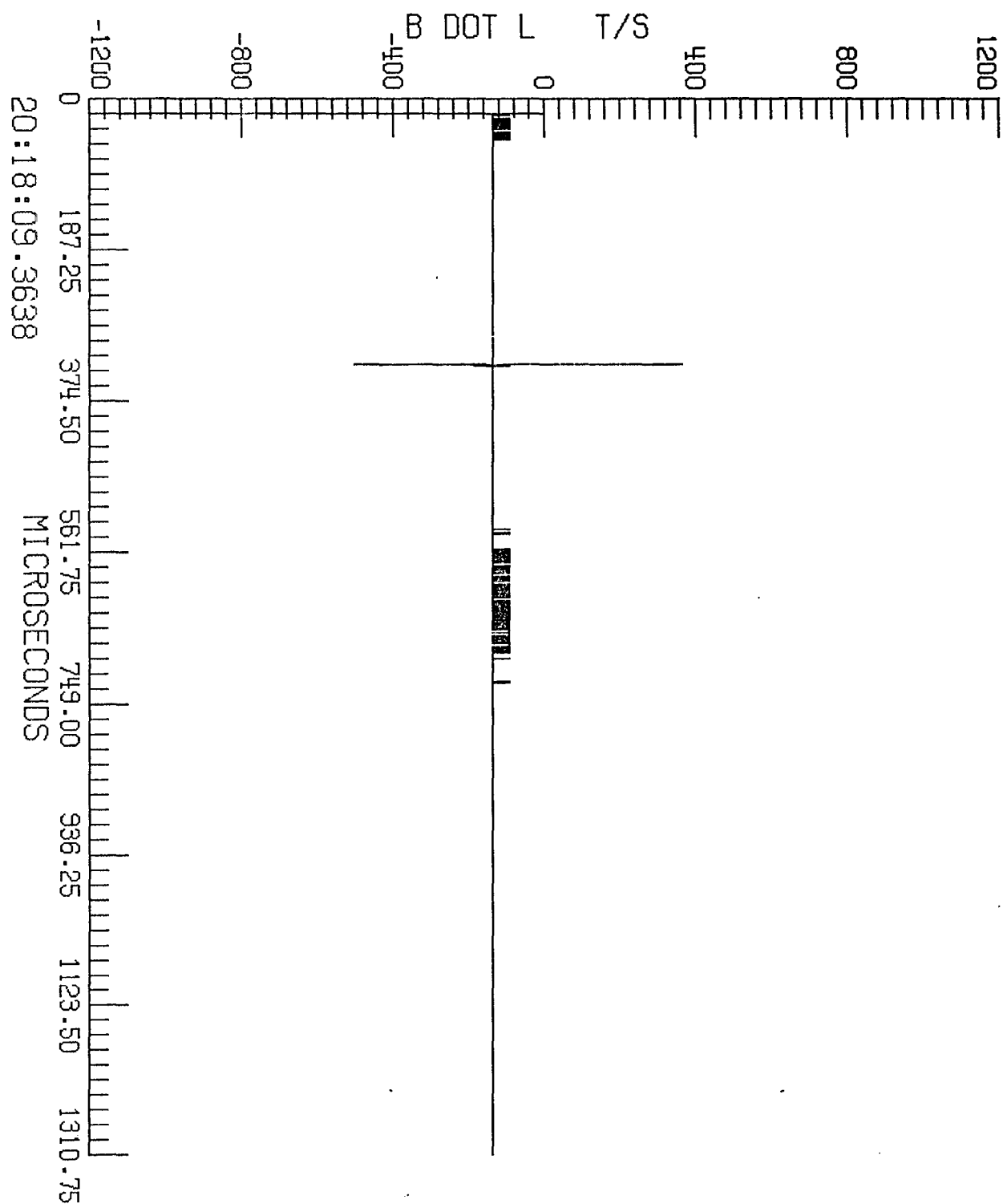


F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83-

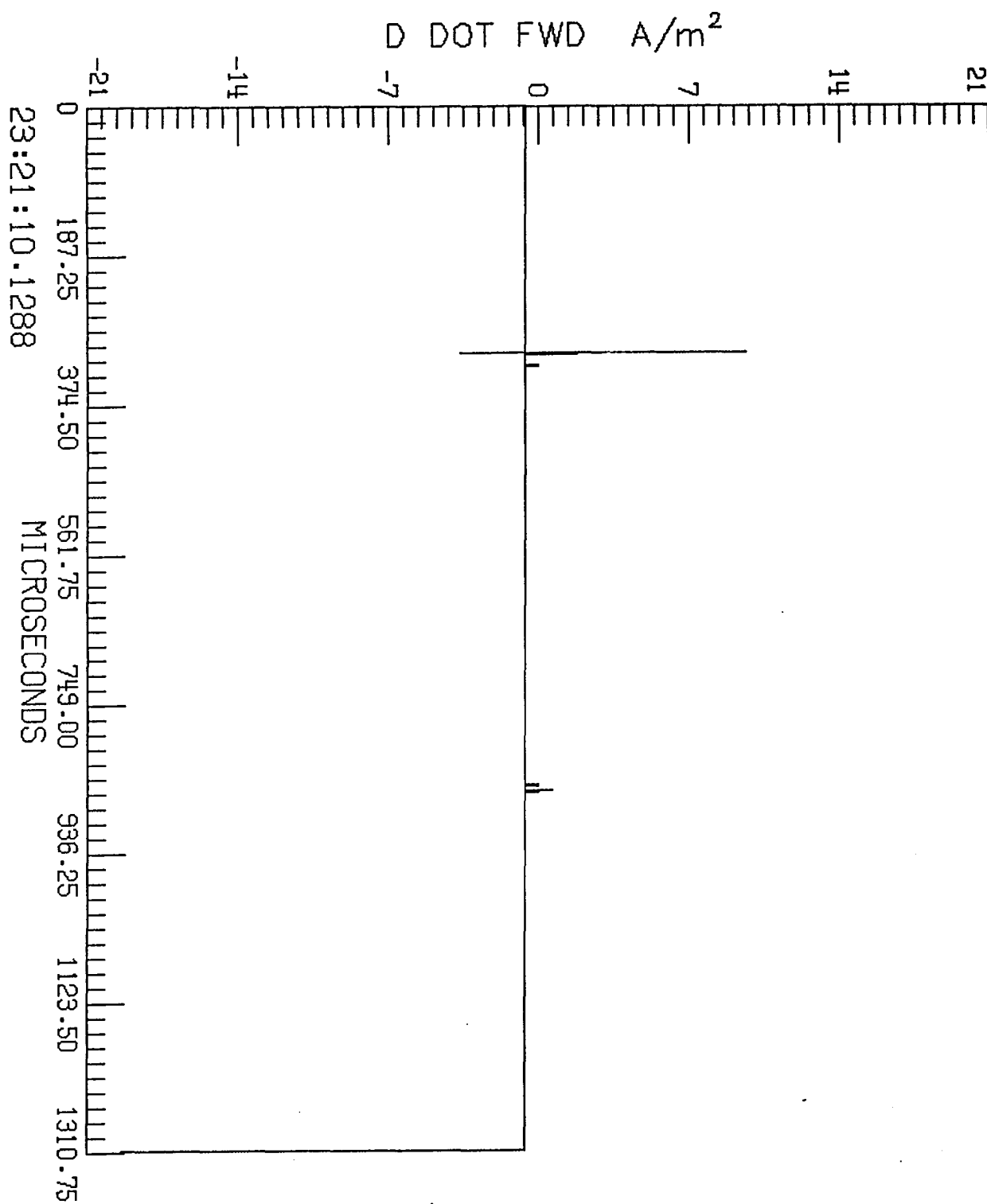
RUN NO. 37

N-022



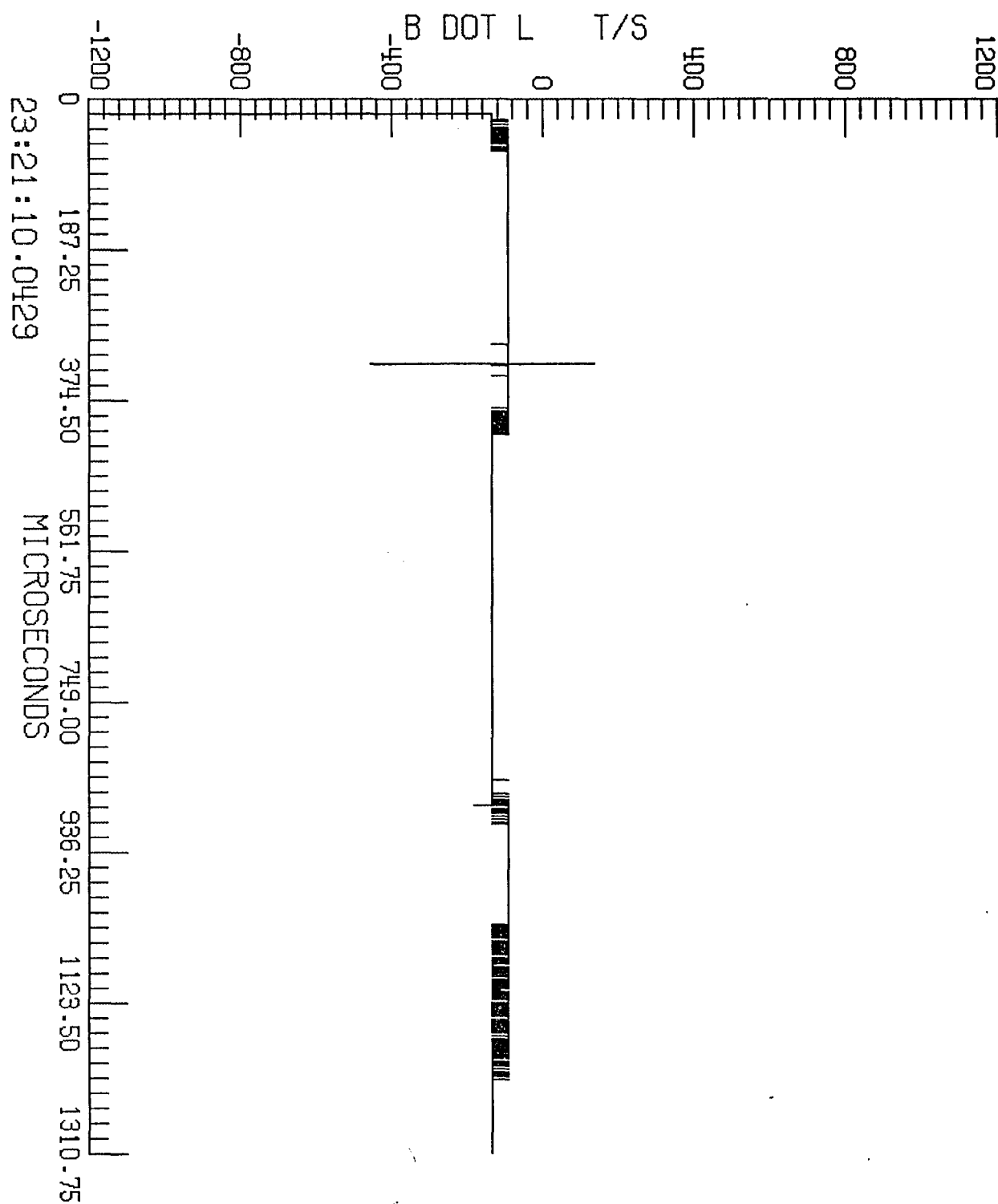
F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 1 S-001

TEST NO. 83.



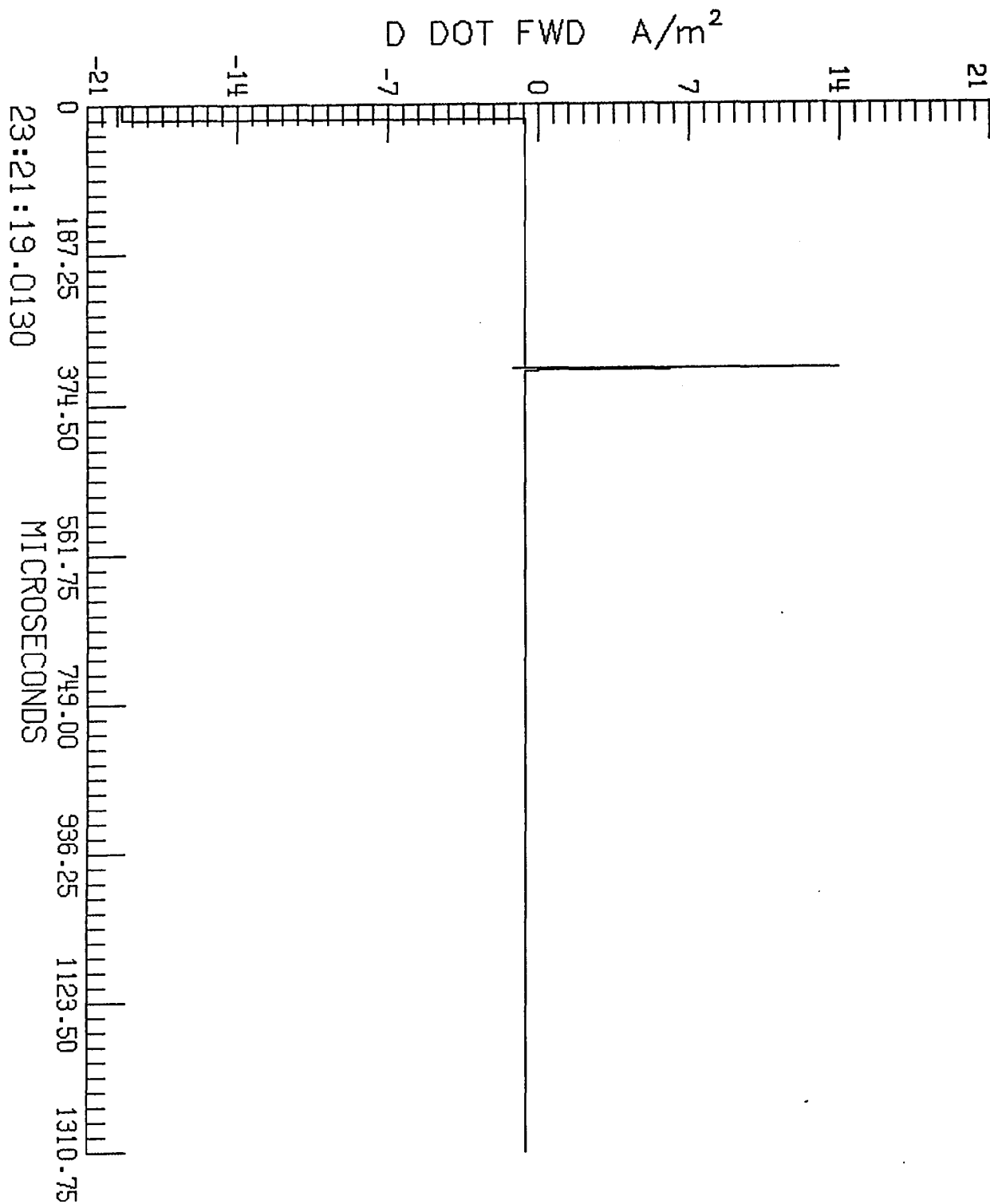
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 1 S-001

TEST NO. 83-



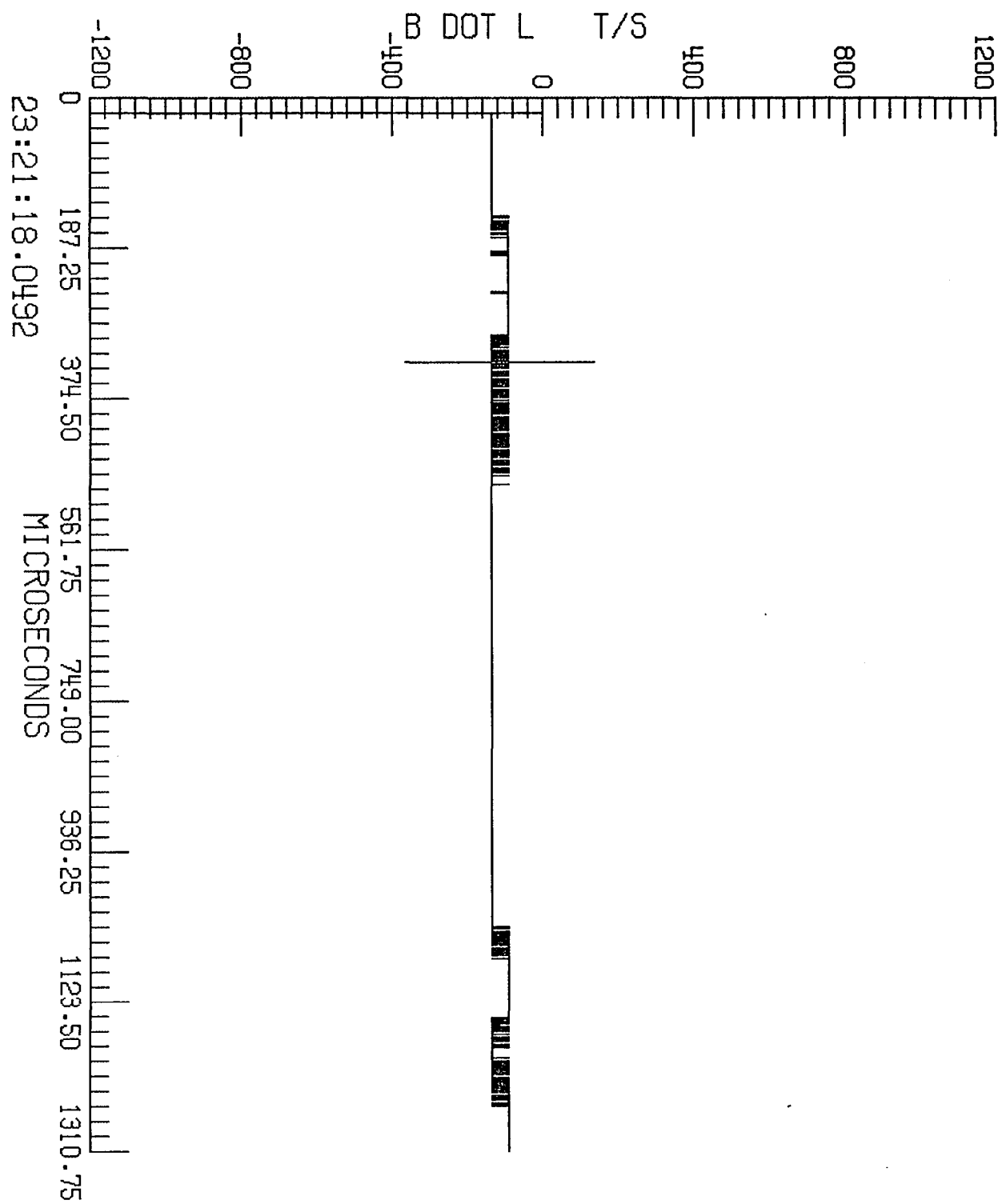
F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 2 S-002

TEST NO. 83



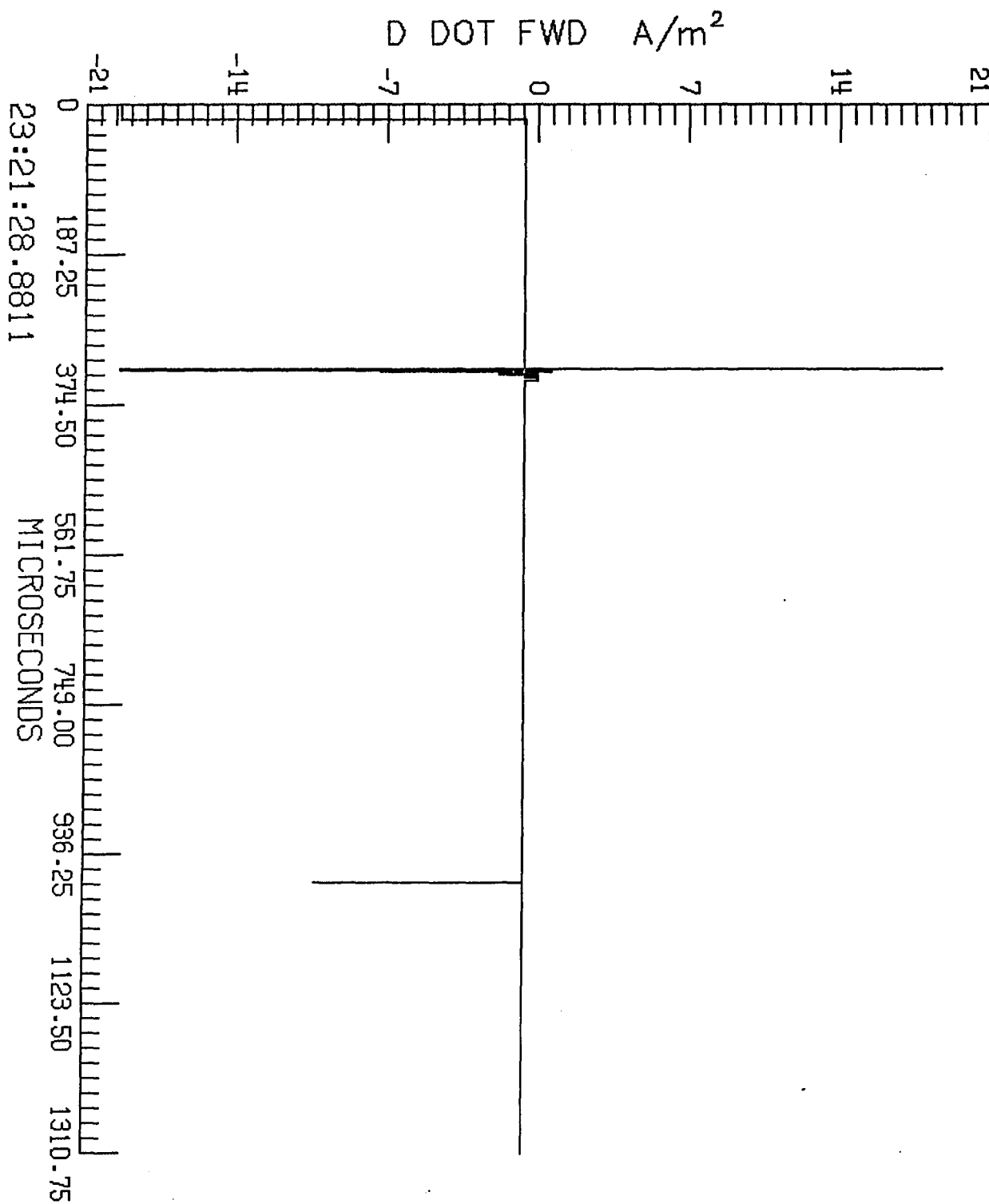
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 2 S-002

TEST NO. 83-



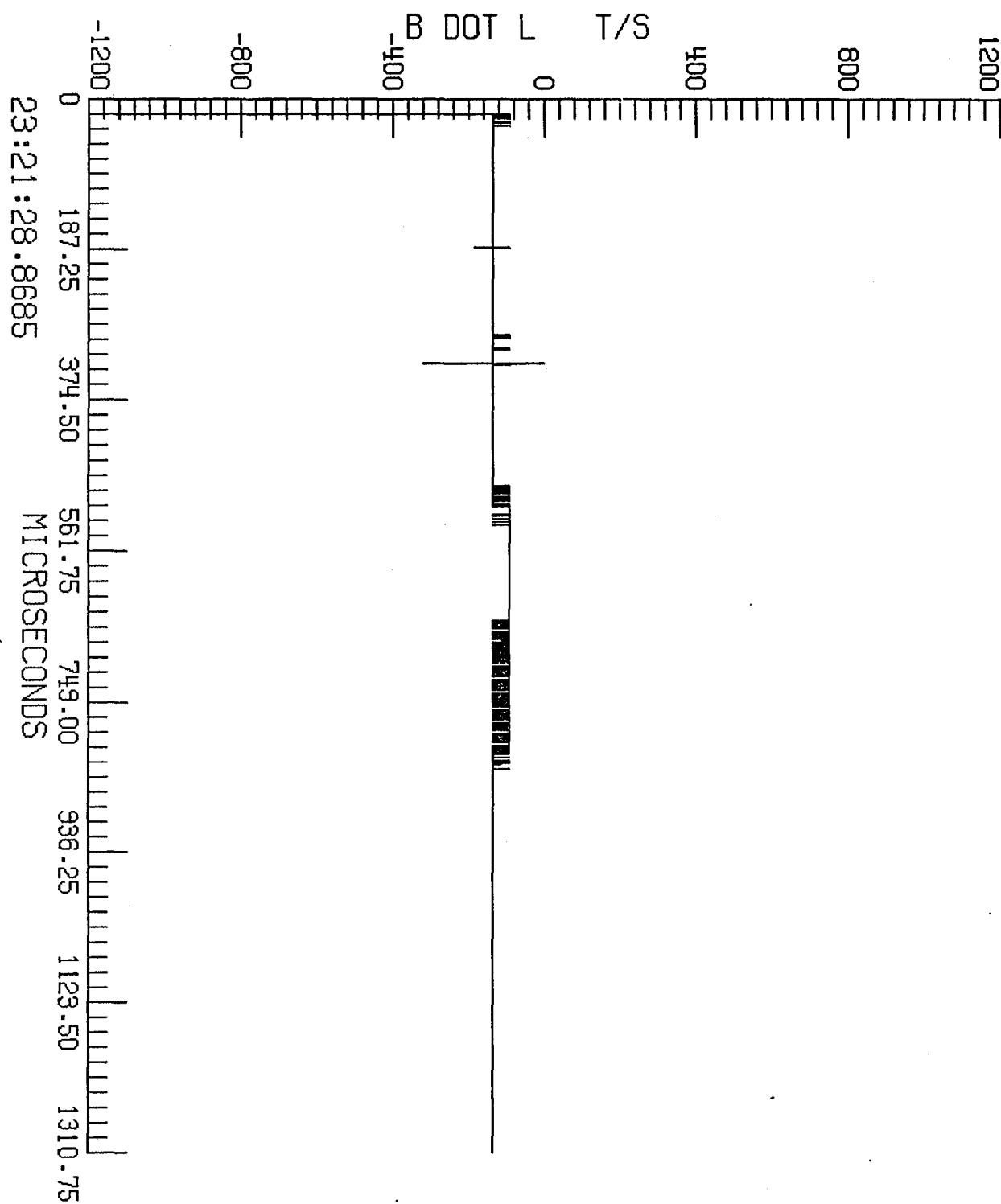
F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 3 S-003

TEST NO. 83



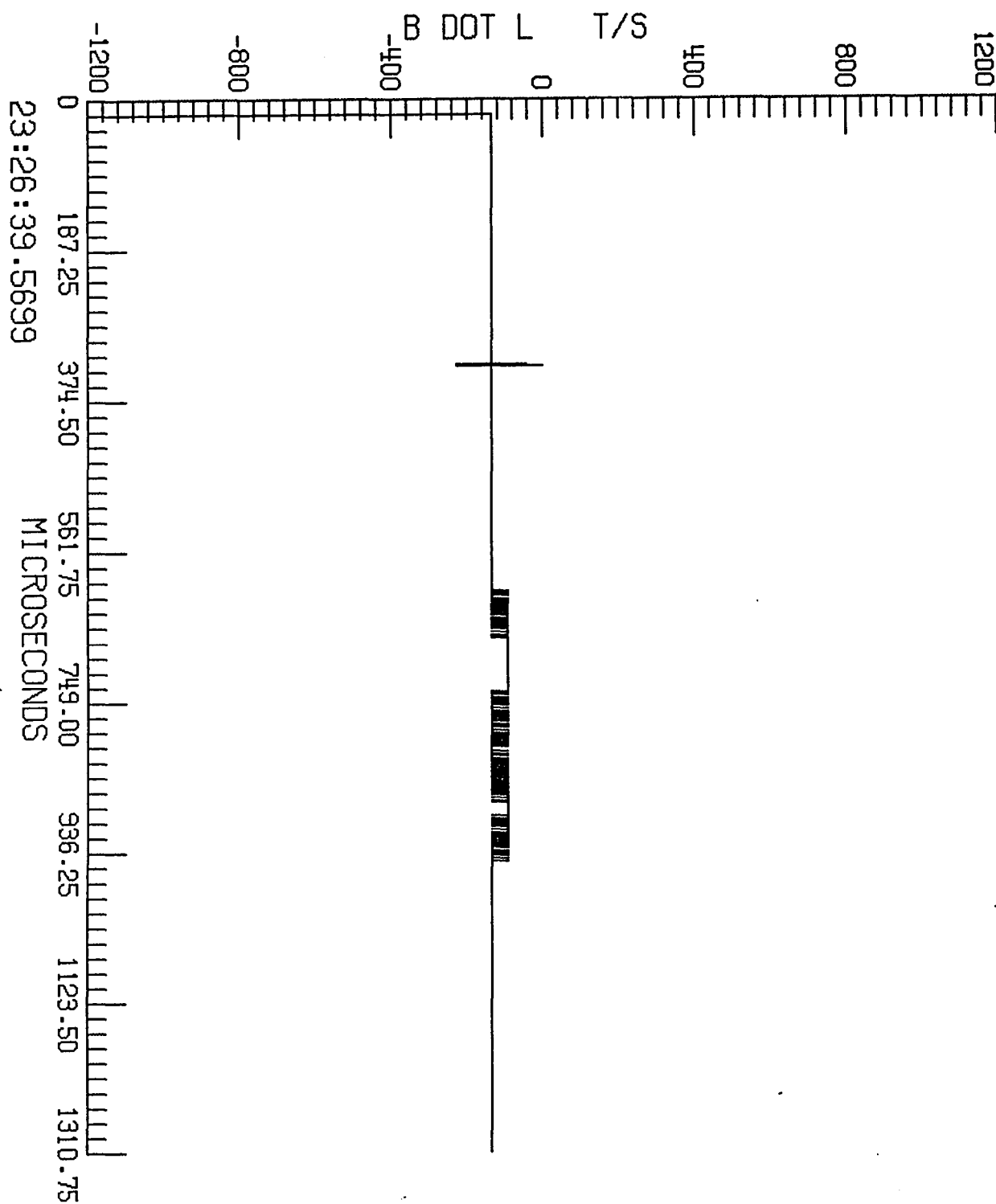
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 3 S-003

TEST NO. 83-



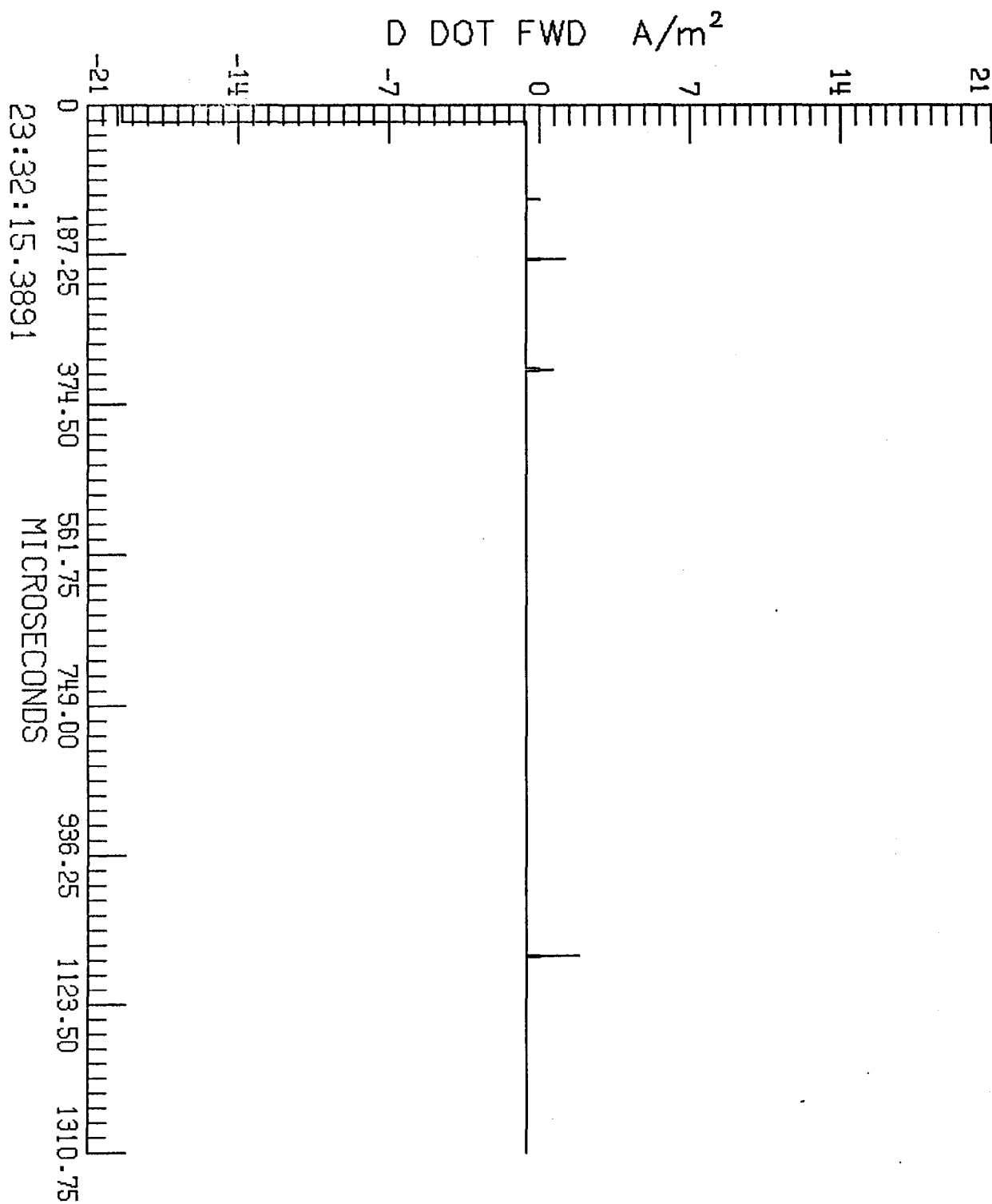
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 4 N-001

TEST NO. 83.



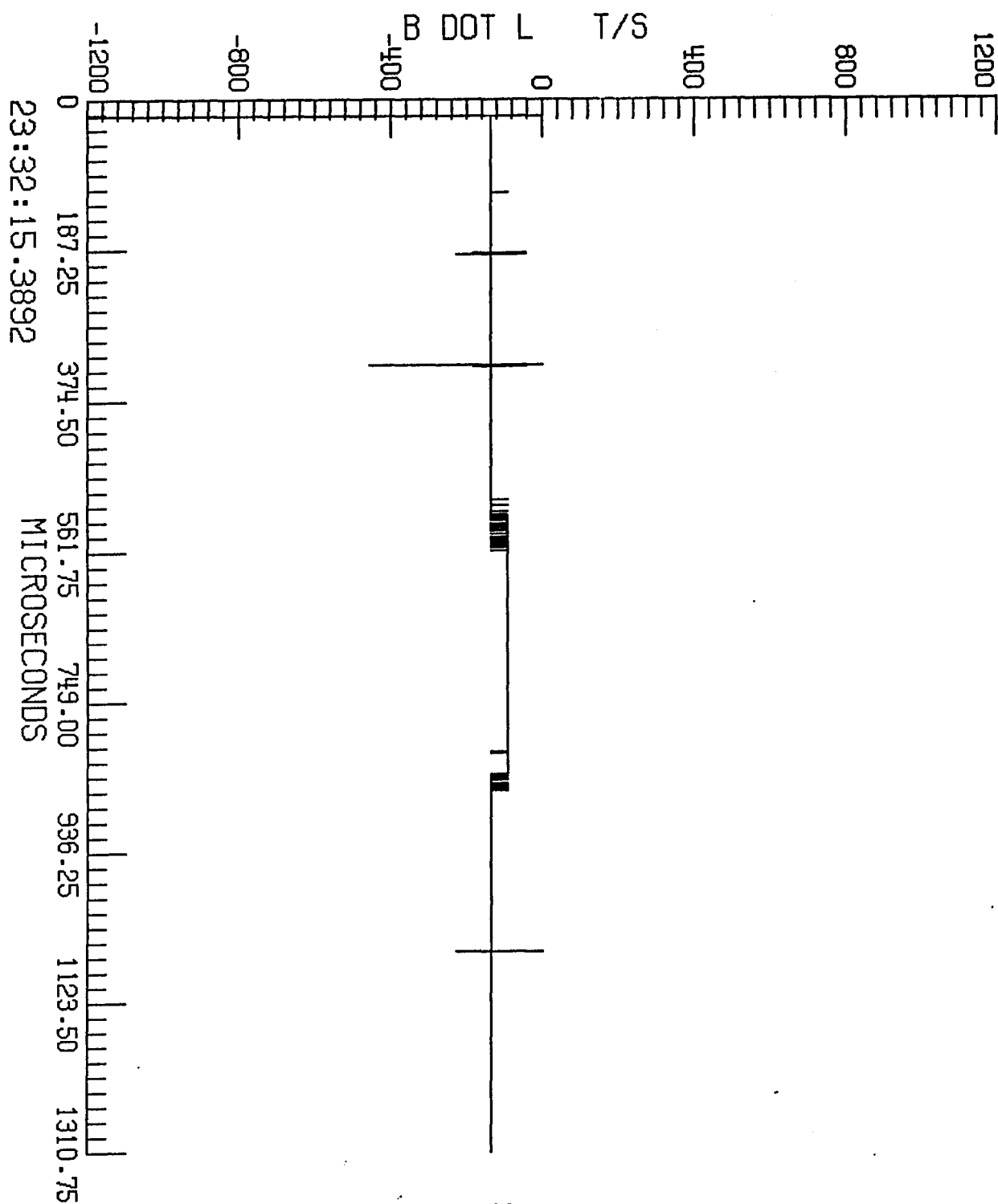
F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 5 S-004

TEST NO. 83



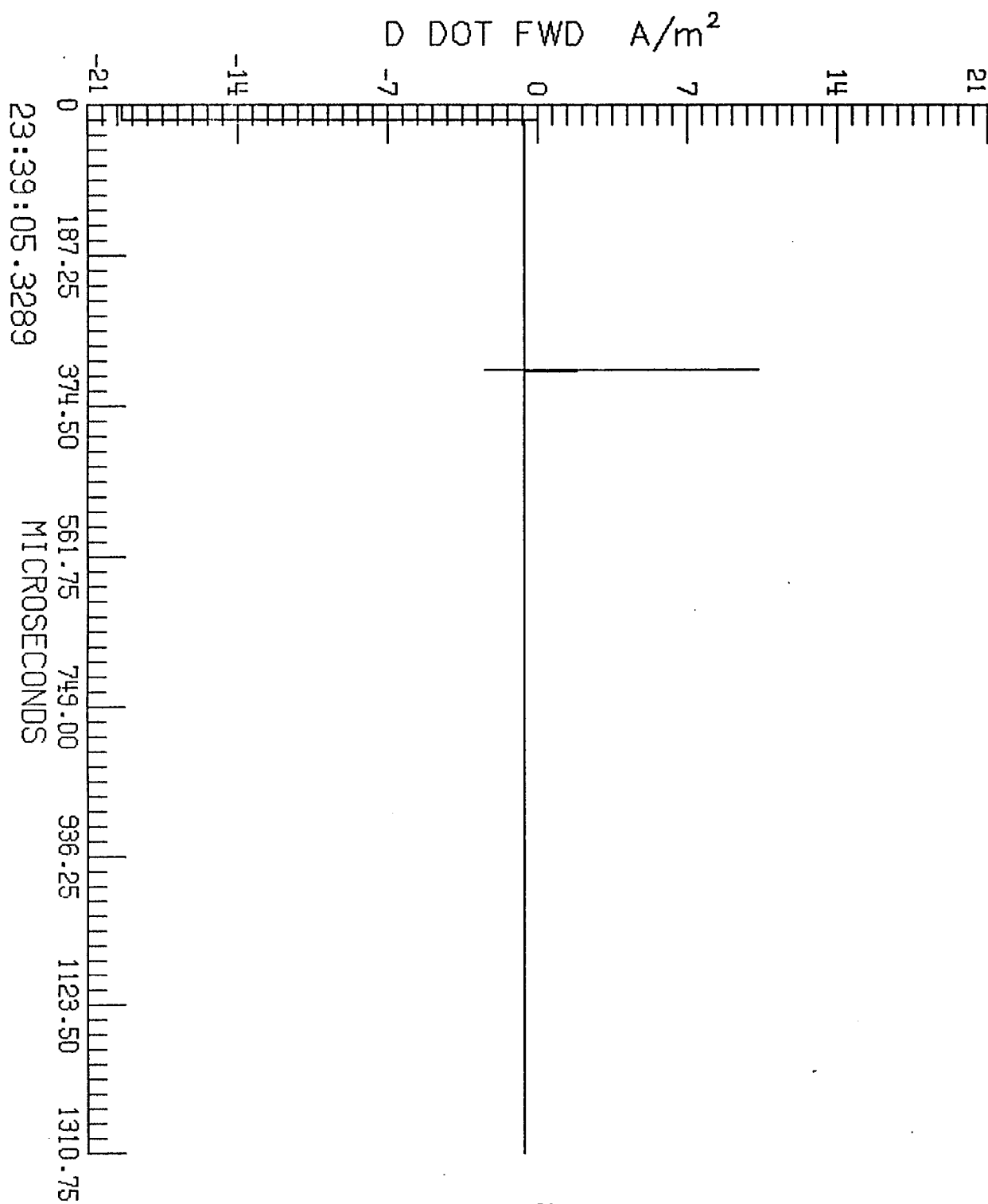
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 5 S-004

TEST NO. 83-



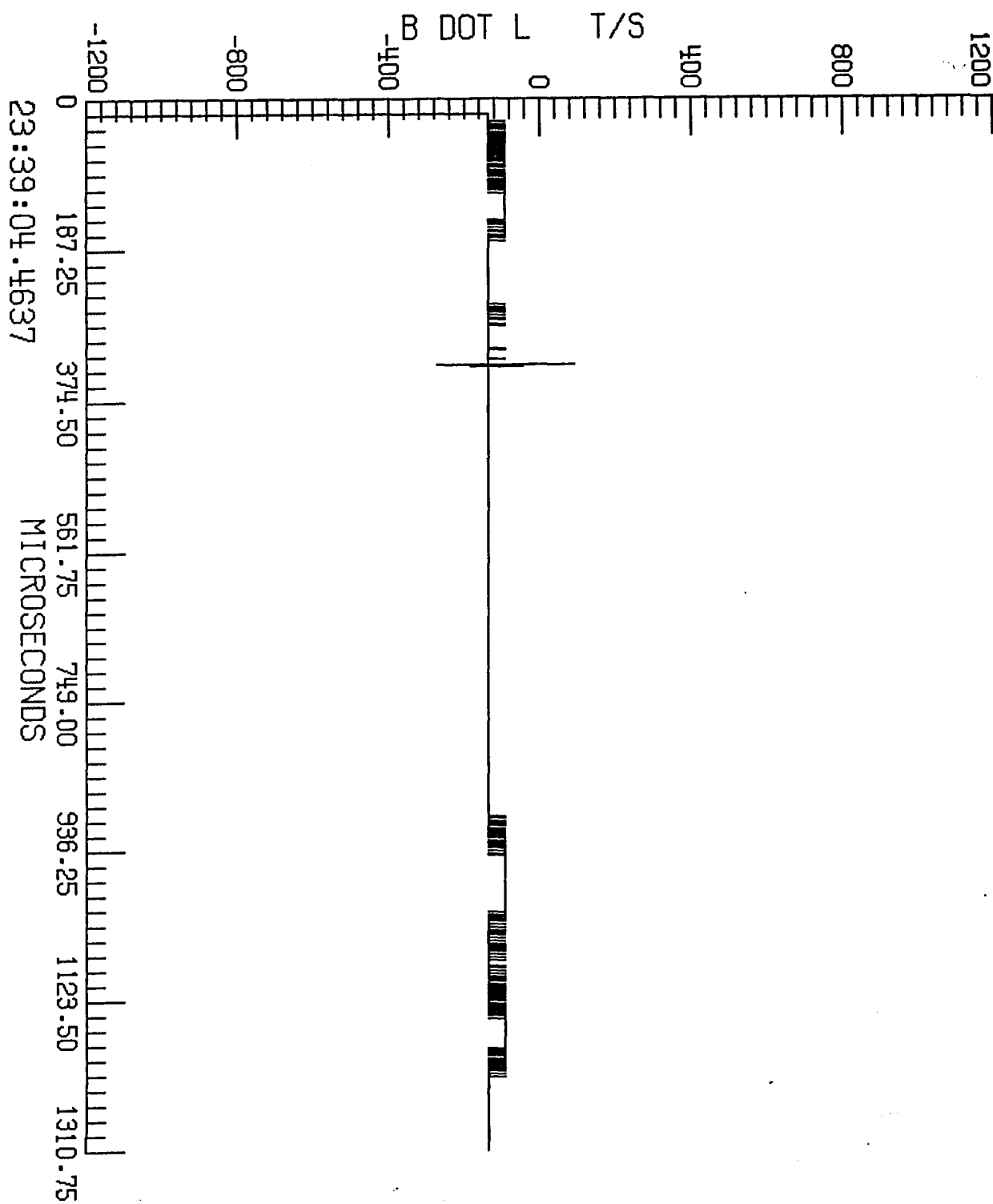
F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 6 N-002

TEST NO. 83



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 6 N-002

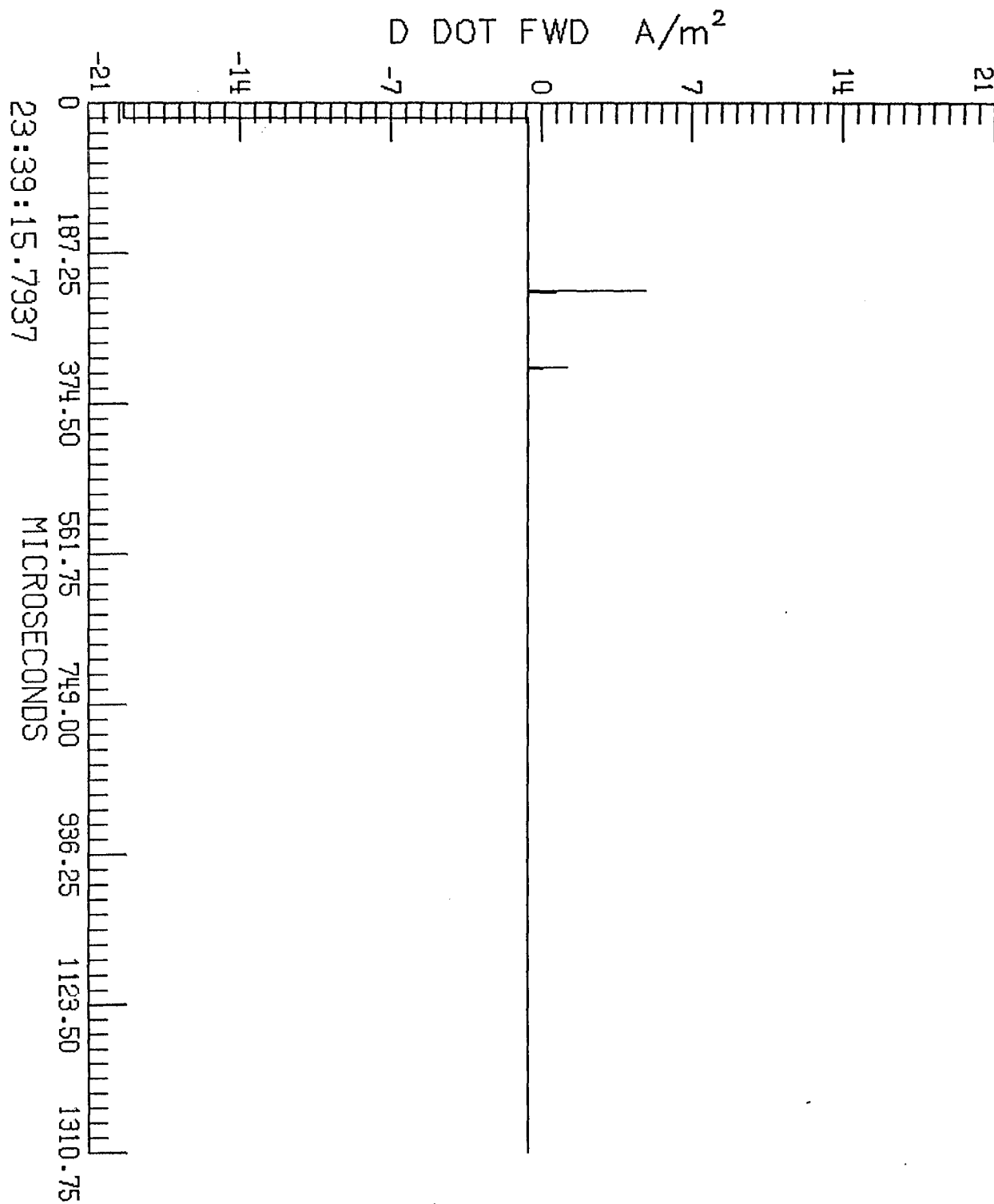
TEST NO. 83



F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 7

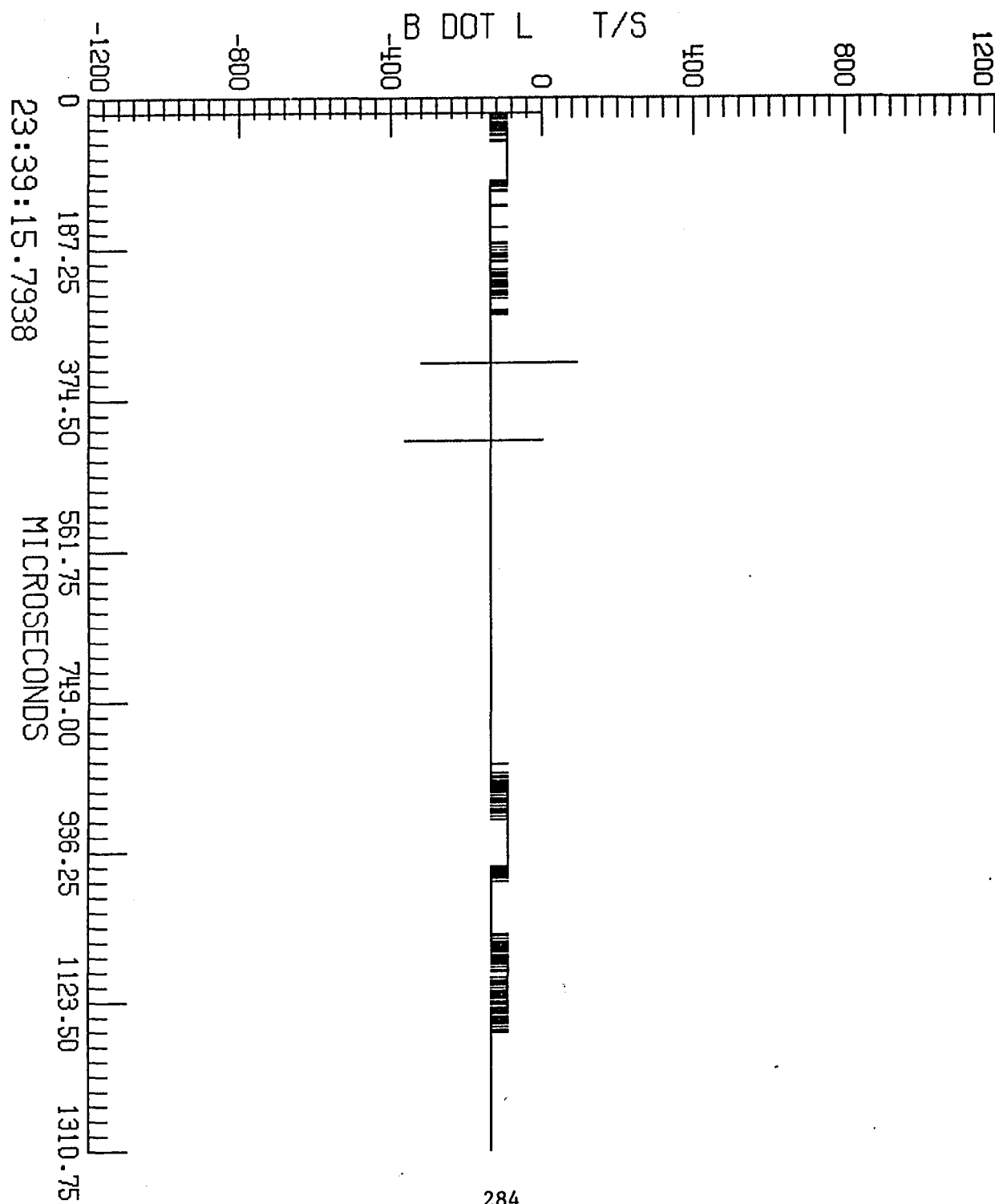
N-003

TEST NO. 83



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 7

TEST NO. 83

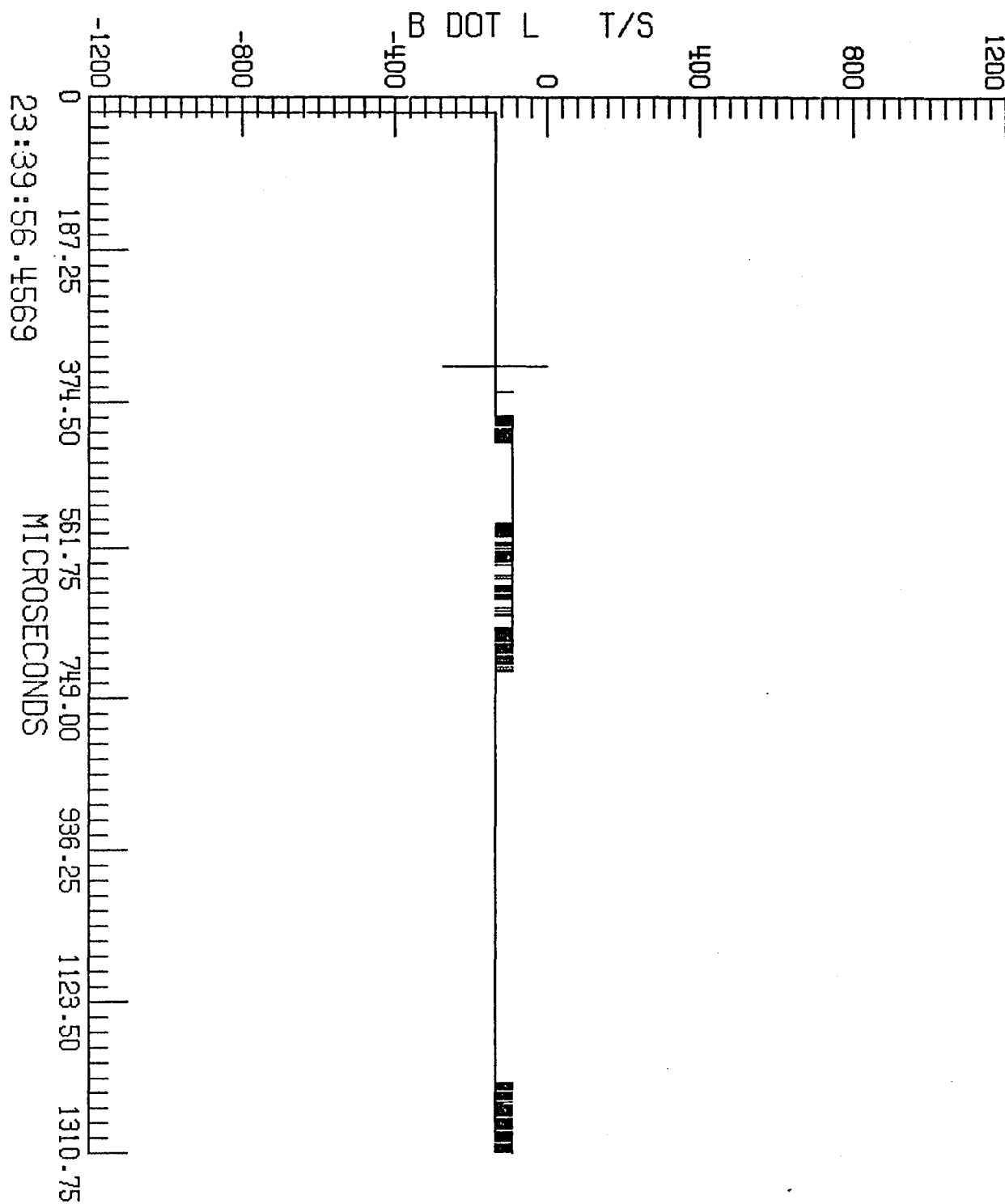


F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83-03'

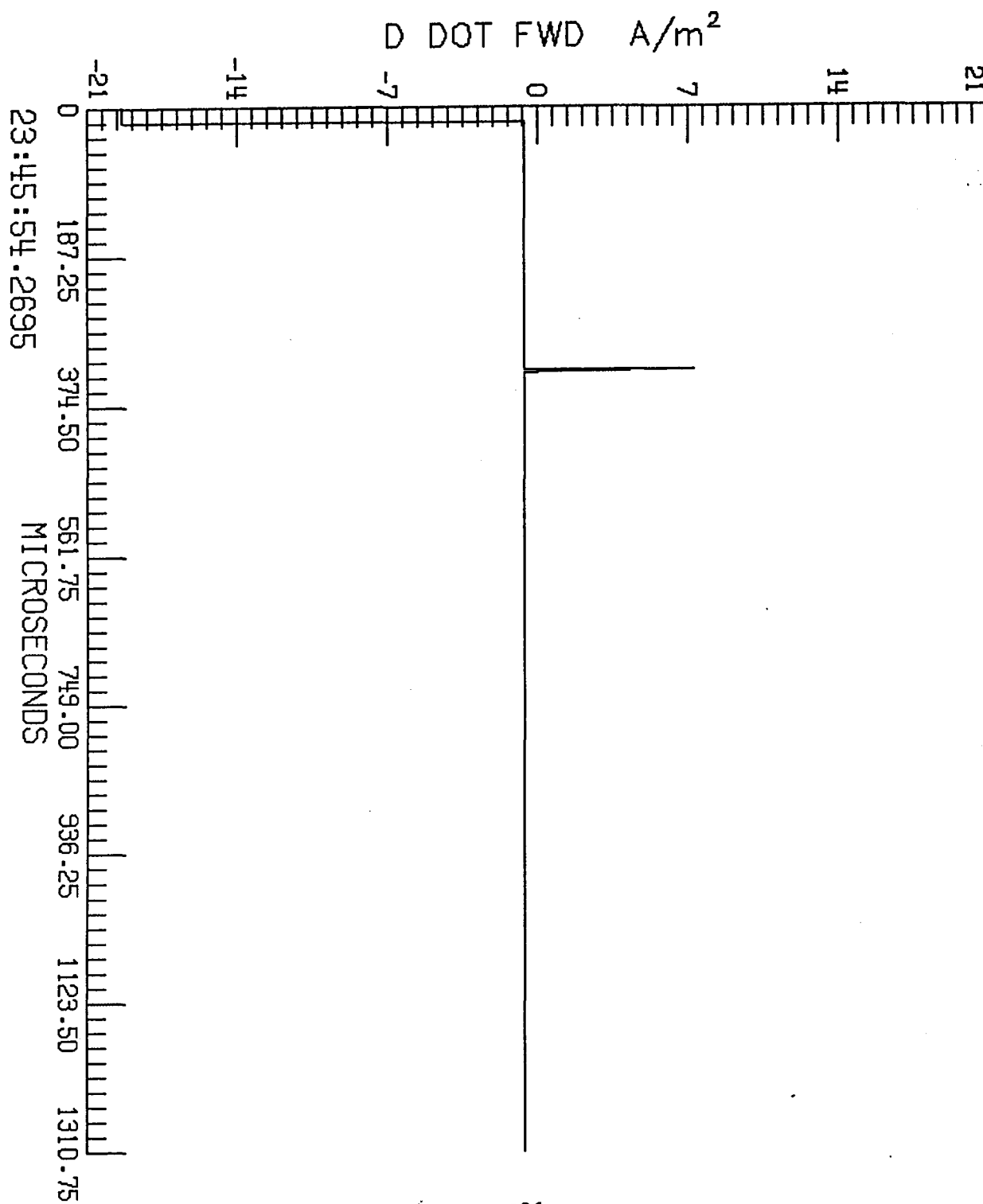
RUN NO. 8

S-005



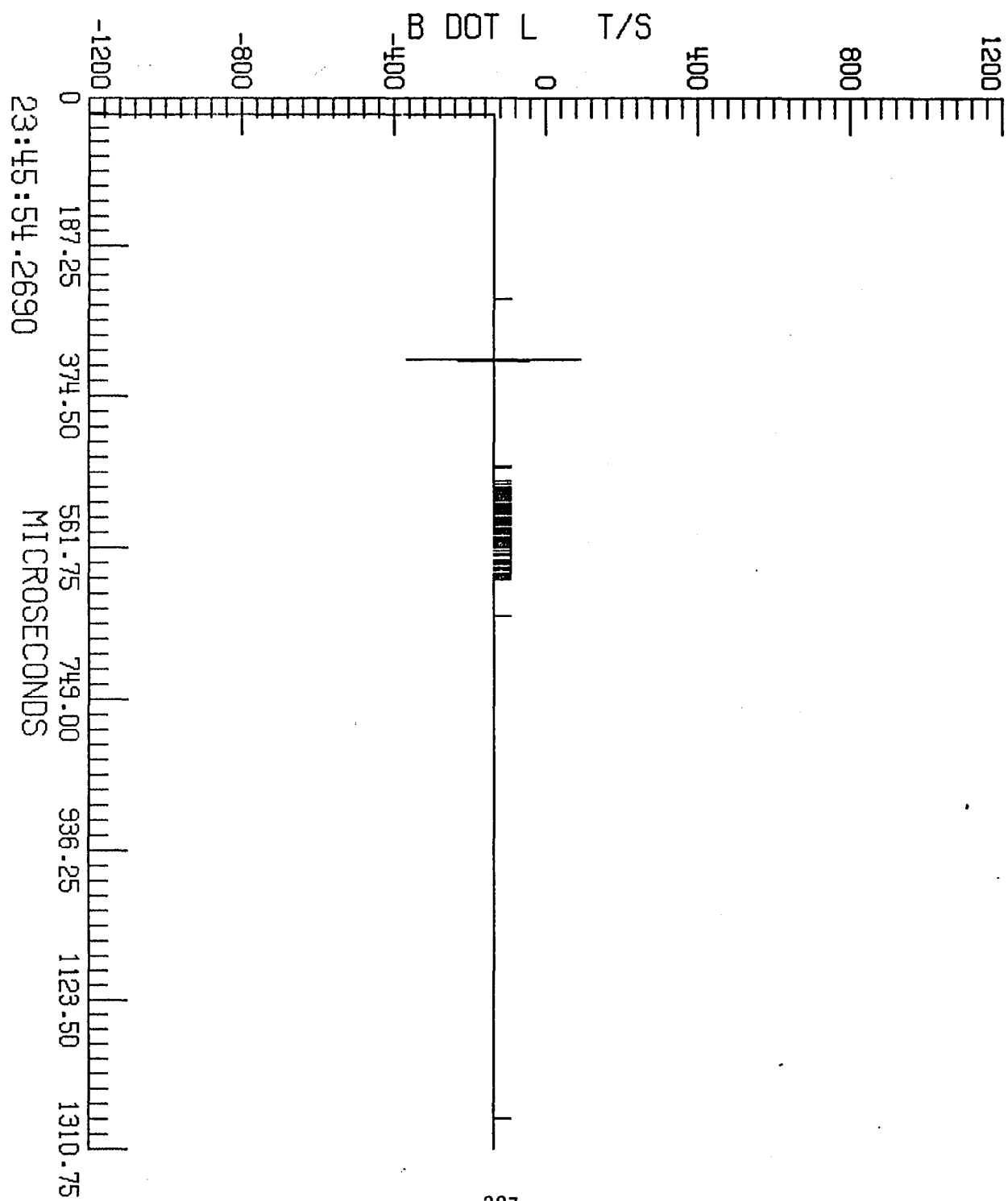
F106 LIGHTNING/TK 8/M.THOMAS
RUN NO. 9 S-007

TEST NO. 83



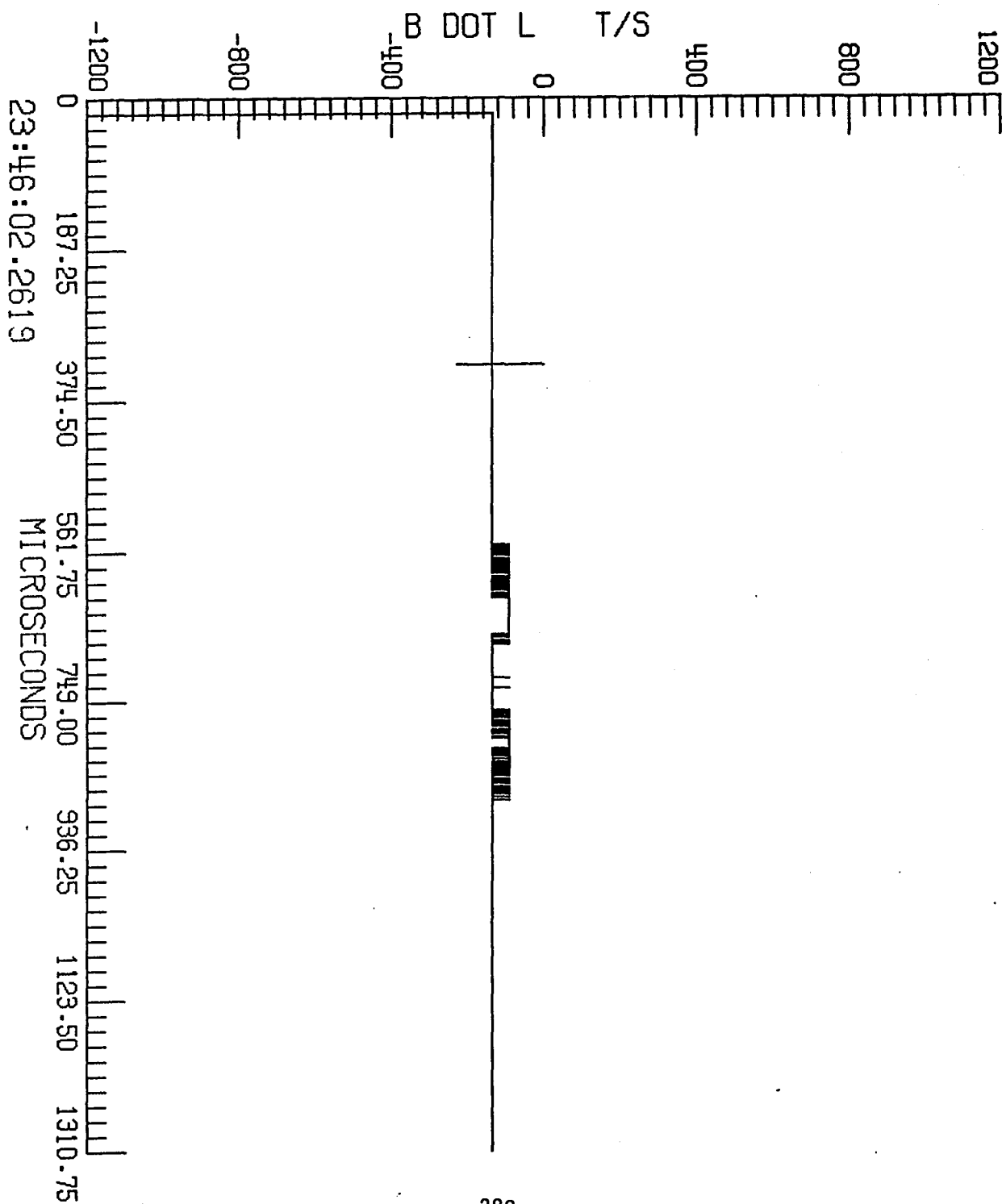
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 9 S-007

TEST NO. 83-03



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 10 N-004

TEST NO. 83-03

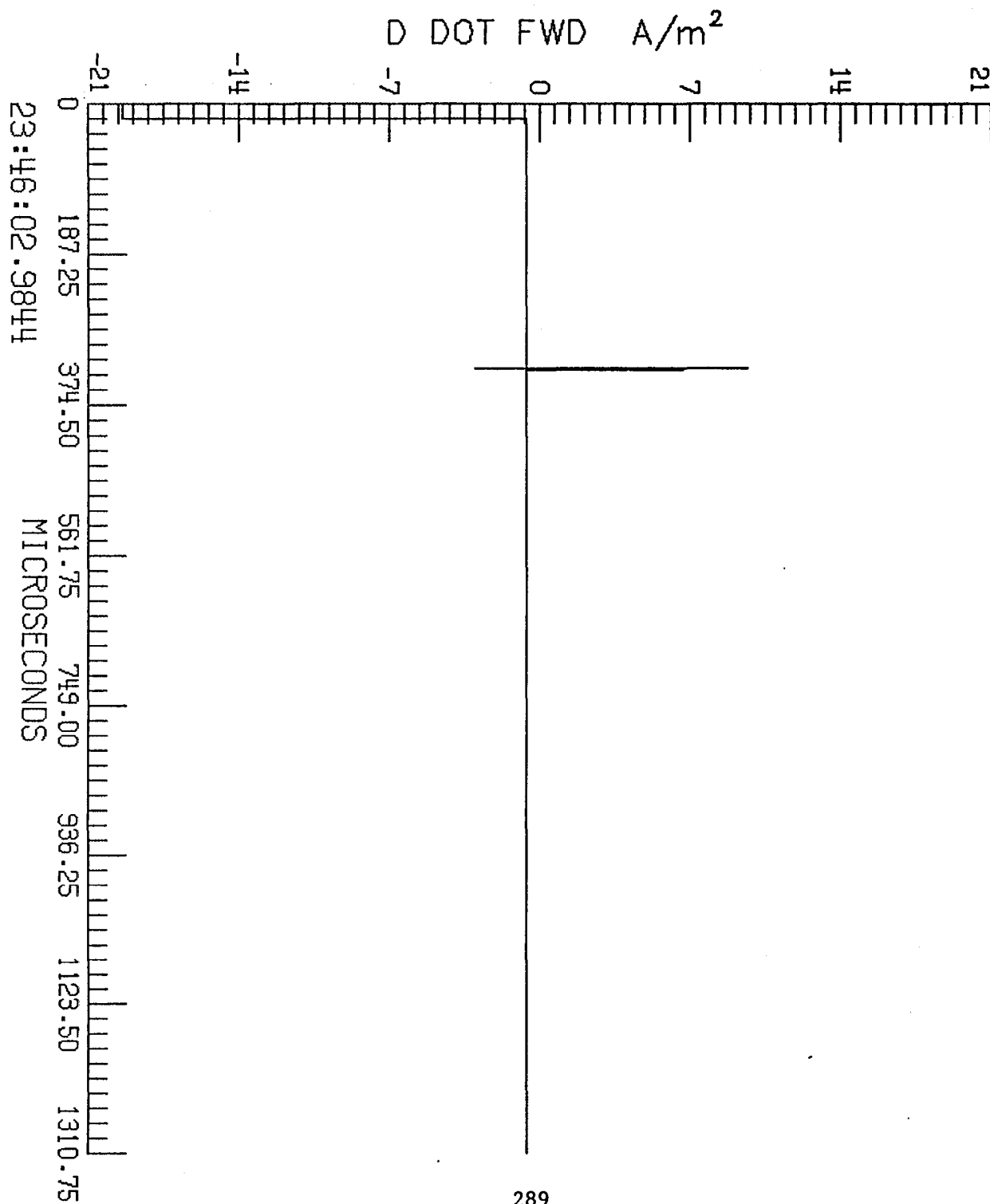


F106 LIGHTNING/TK 8/M.THOMAS

TEST NO. 83

RUN NO. 10

S-008

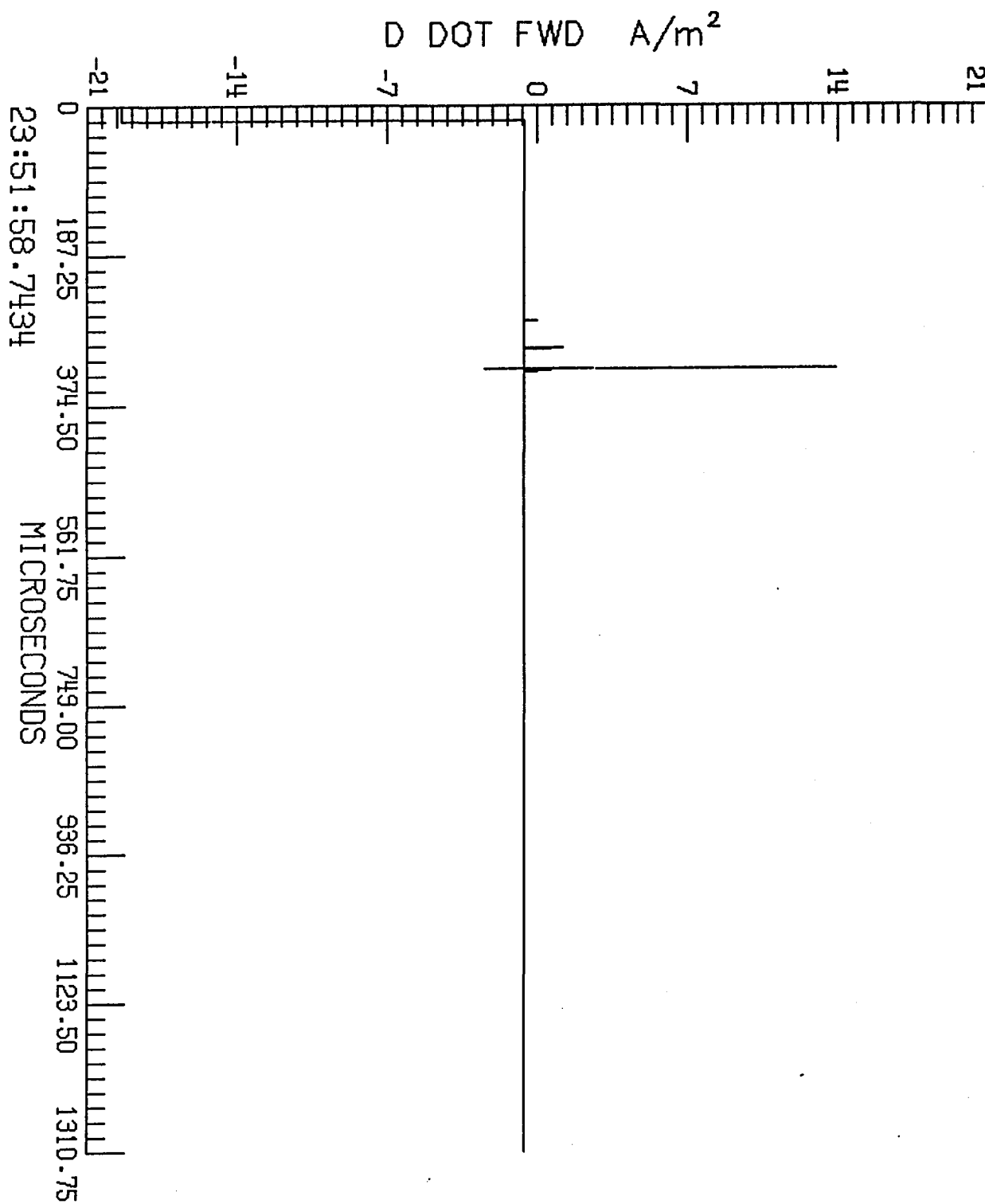


F106 LIGHTNING/TK 8/M.THOMAS

TEST NO. 83

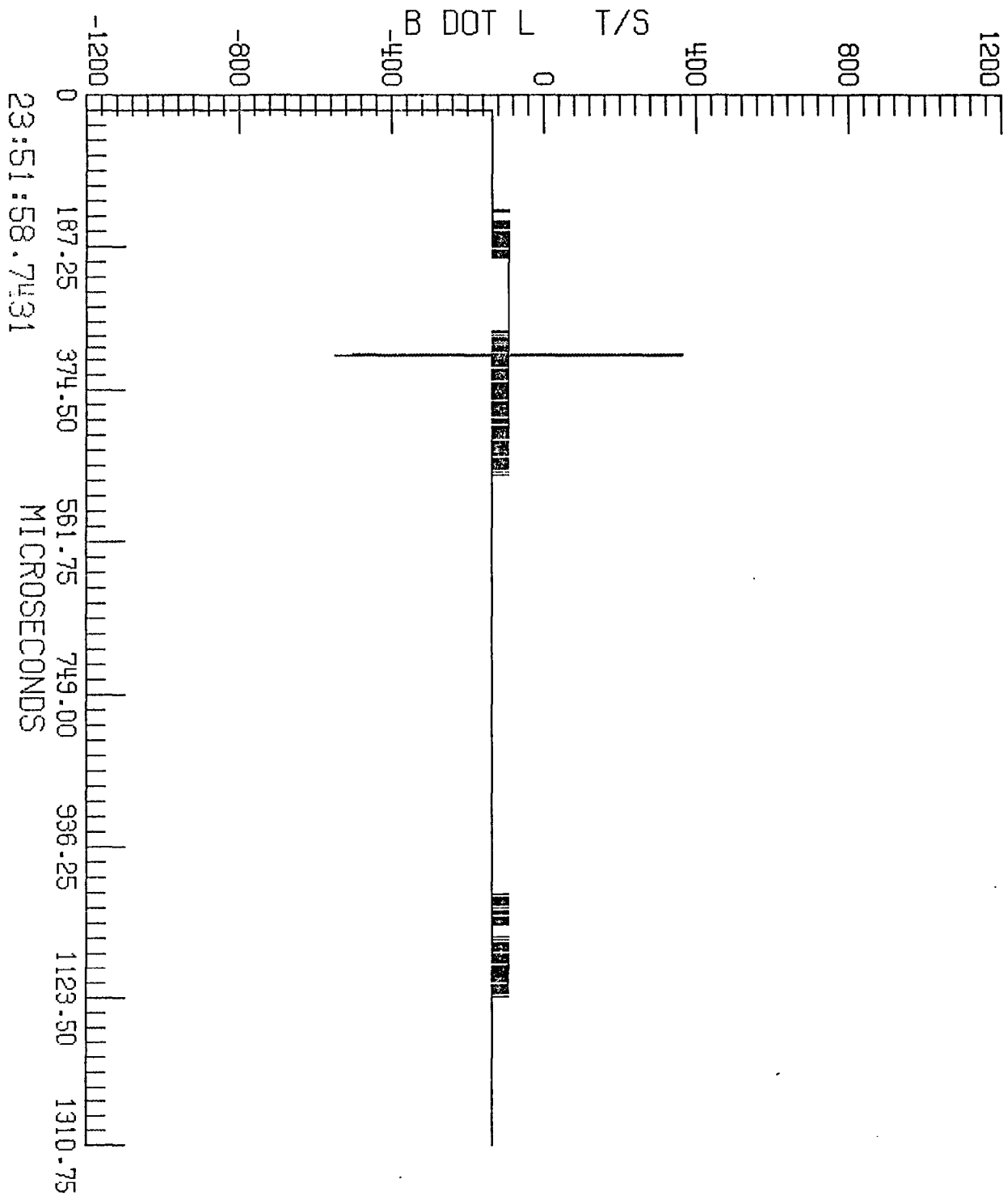
RUN NO. 11

S-009



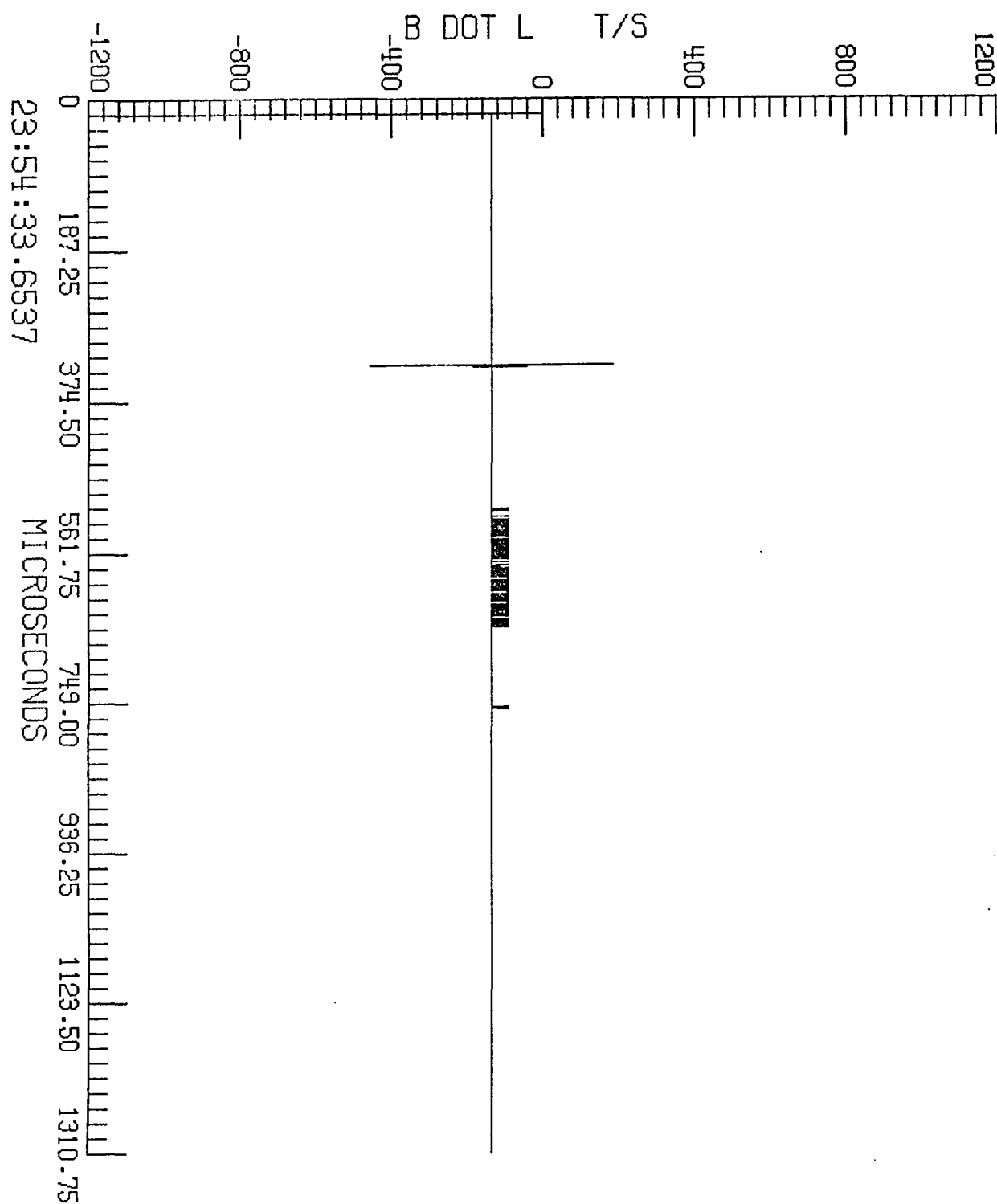
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 11 S-009

TEST NO. 83-03



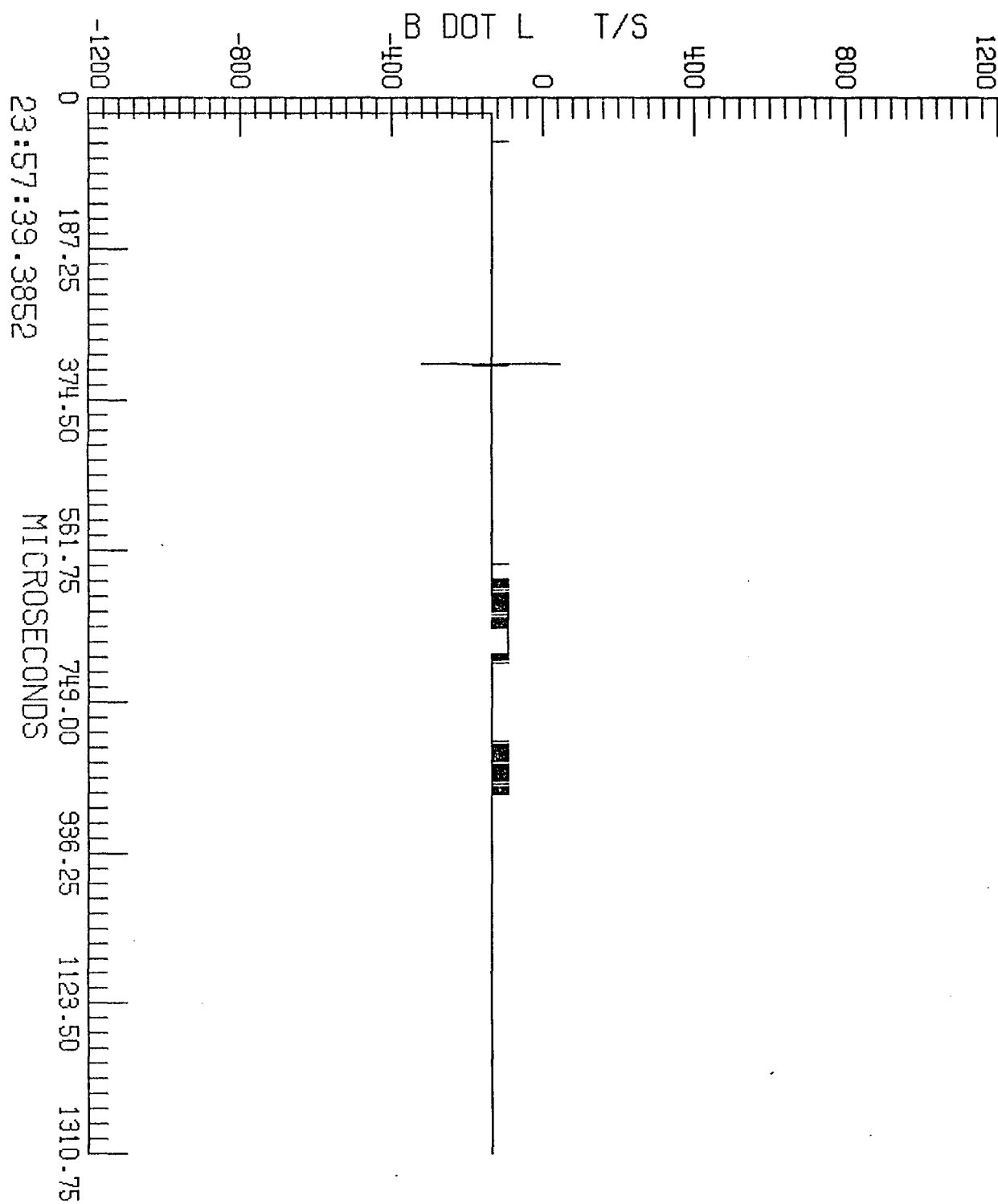
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 12 N-005

TEST NO. 83-03



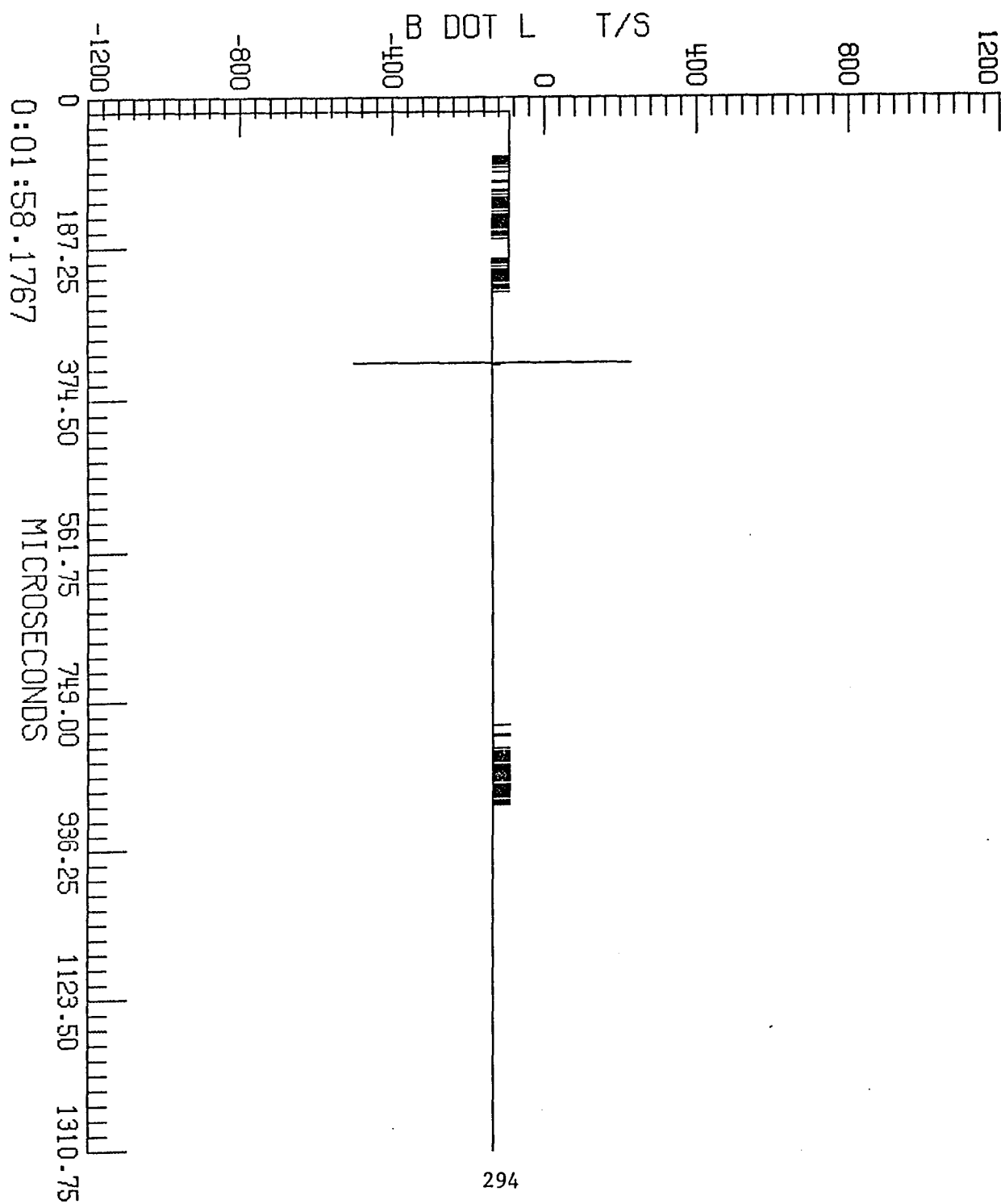
F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 13 S-010

TEST NO. 83-03



F106 LIGHTNING/TK 10/M.THOMAS
RUN NO. 14 N-006

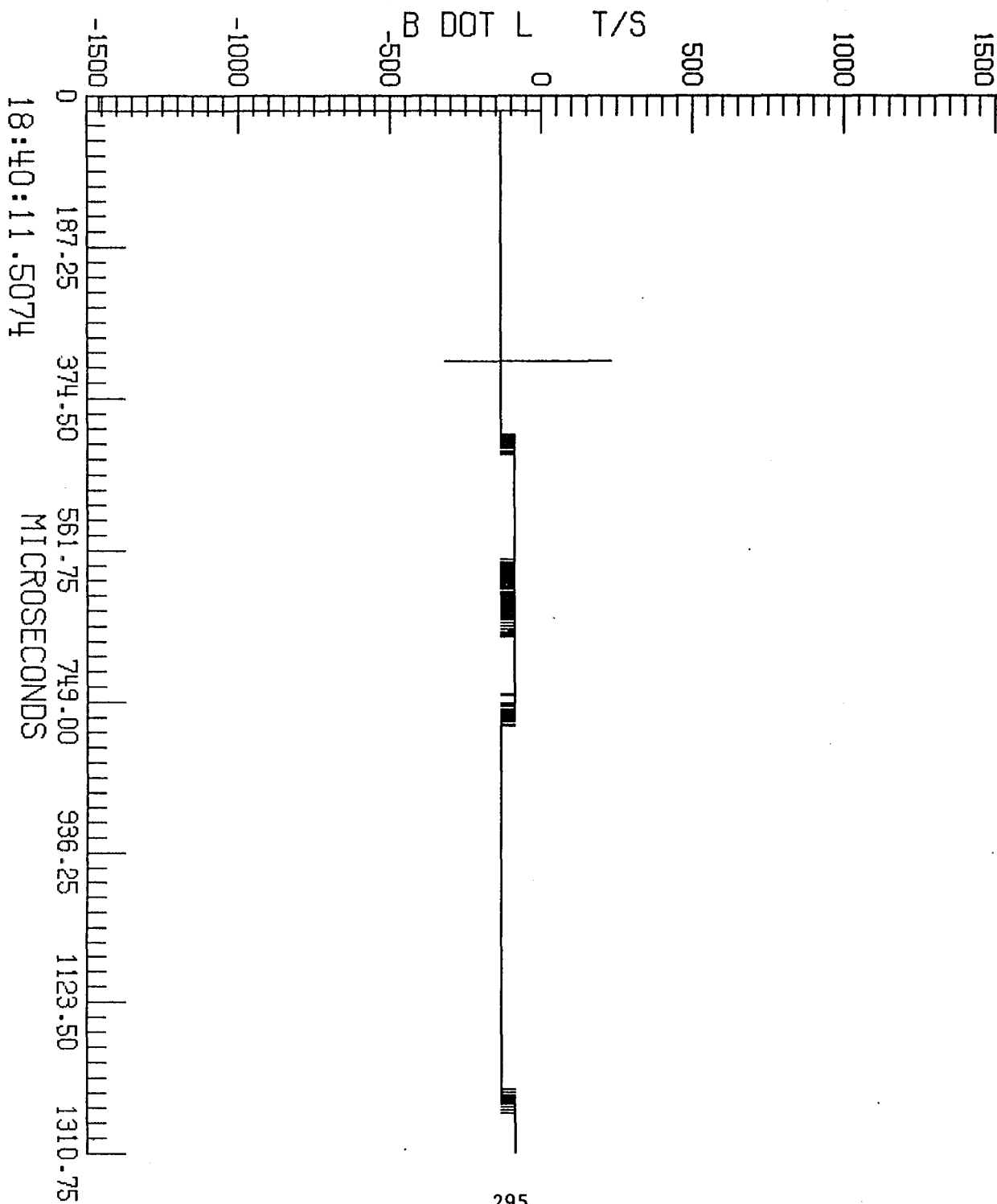
TEST NO. 83-03



F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83

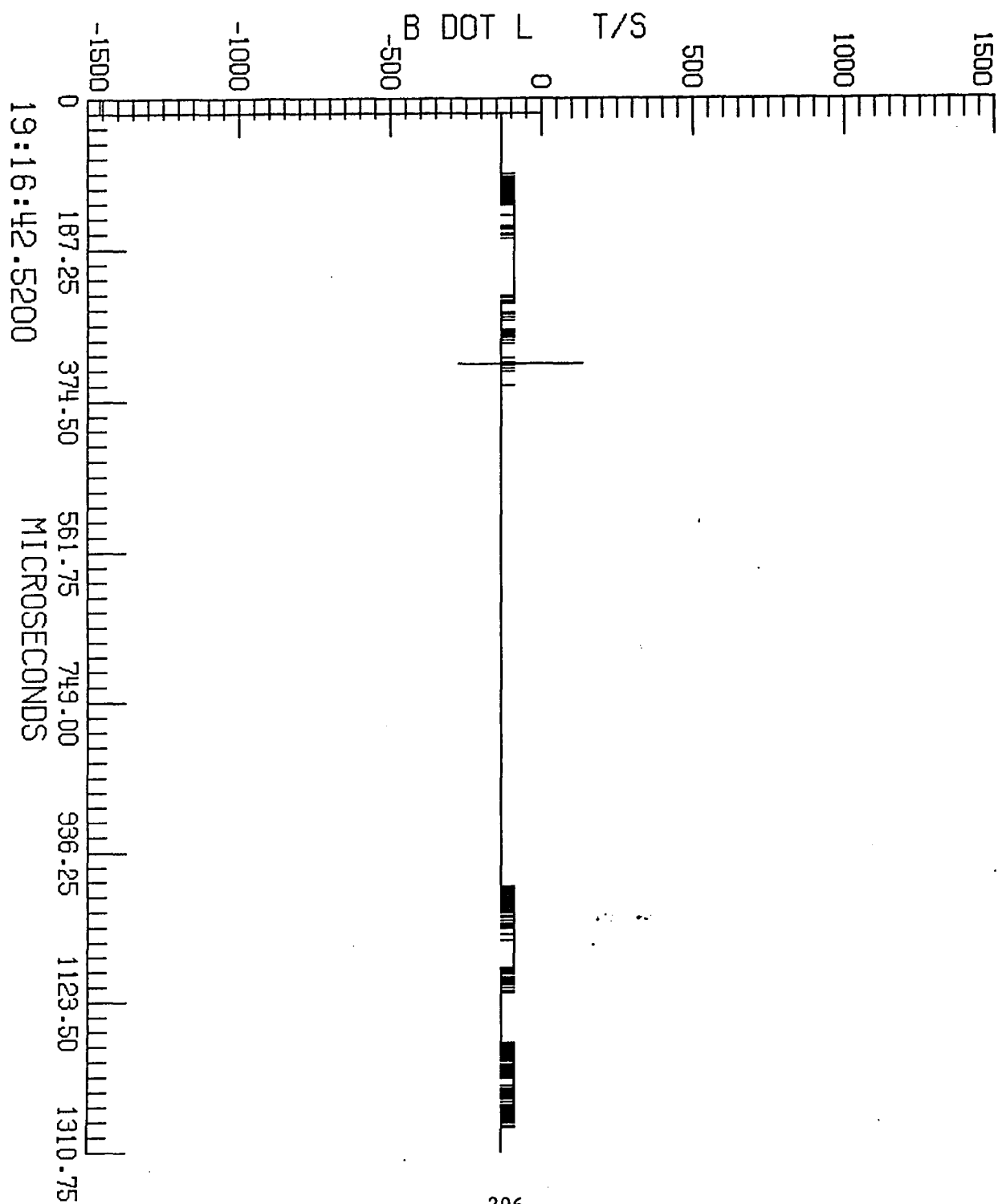
RUN NO. 1 N-001



F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83

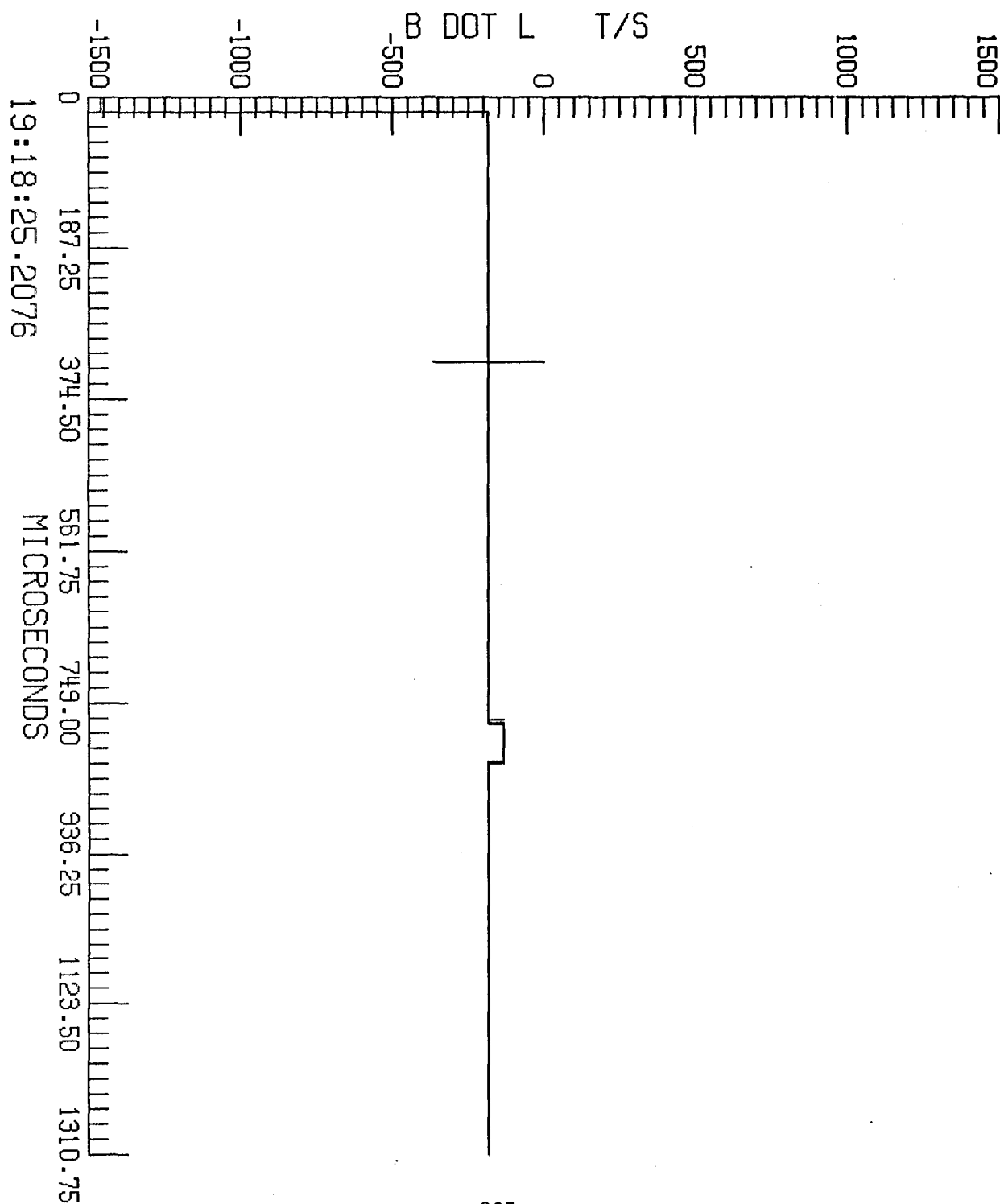
RUN NO. 2 S-001



F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83

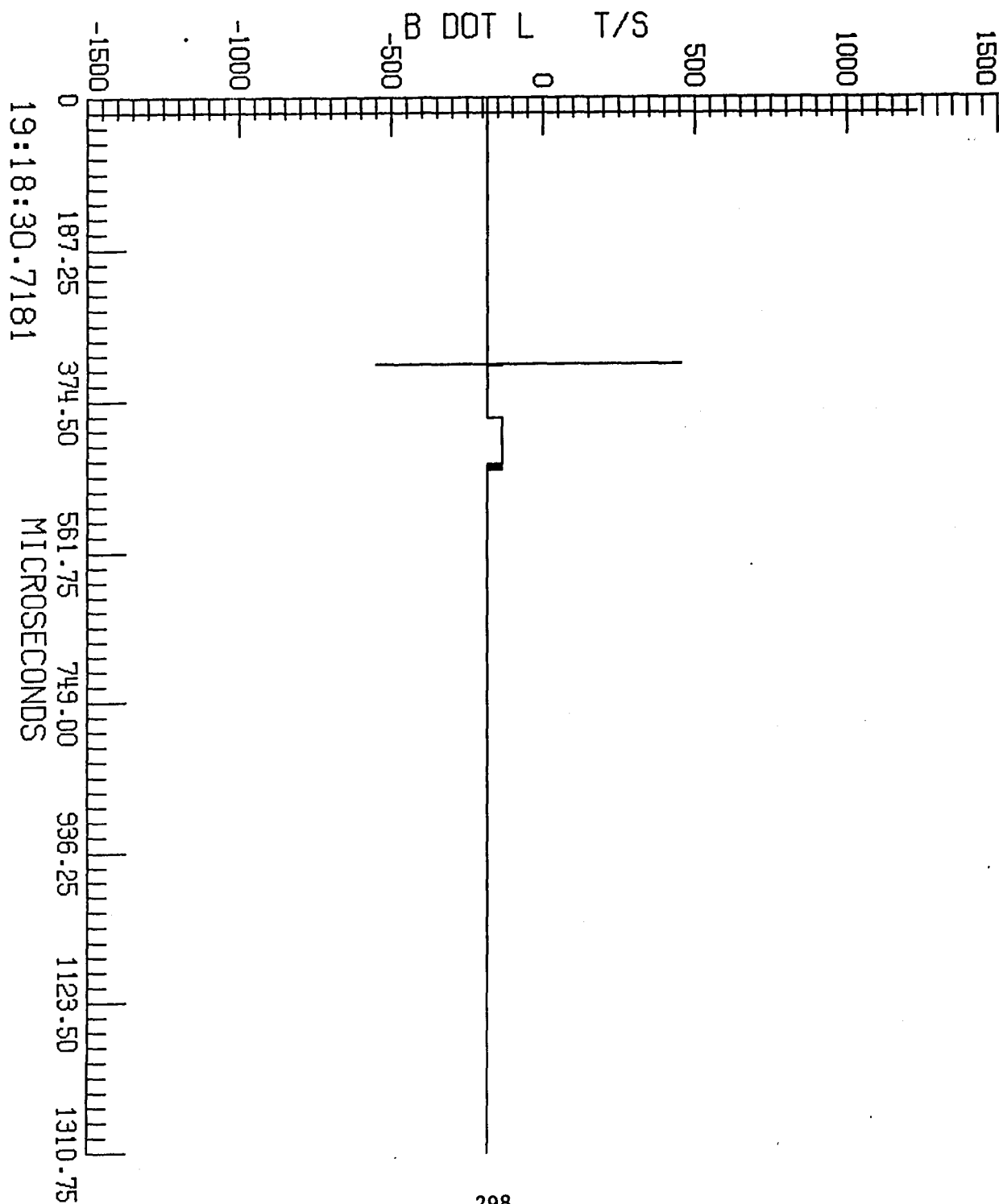
RUN NO. 3 N-002

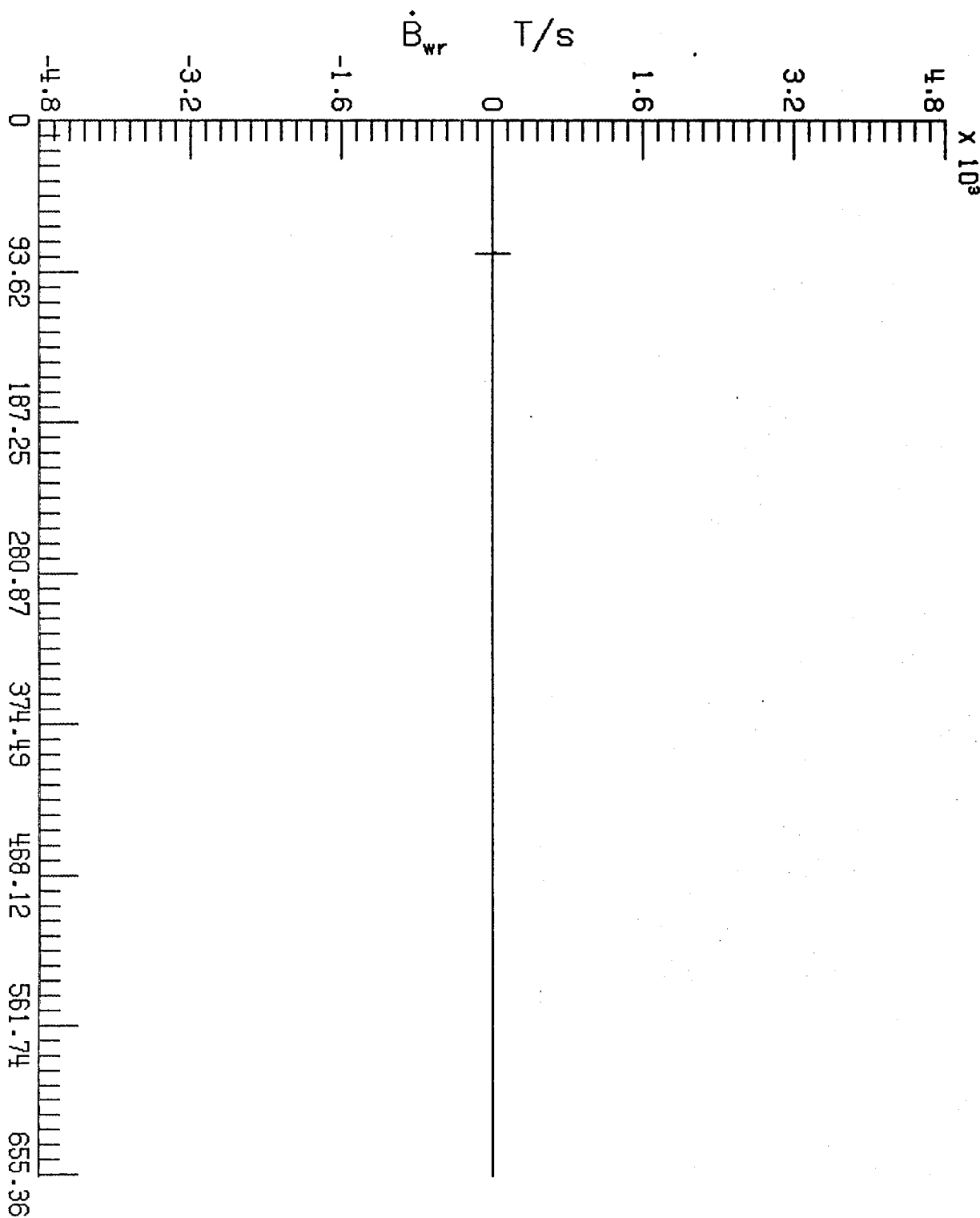


F106 LIGHTNING/TK 10/M.THOMAS

TEST NO. 83

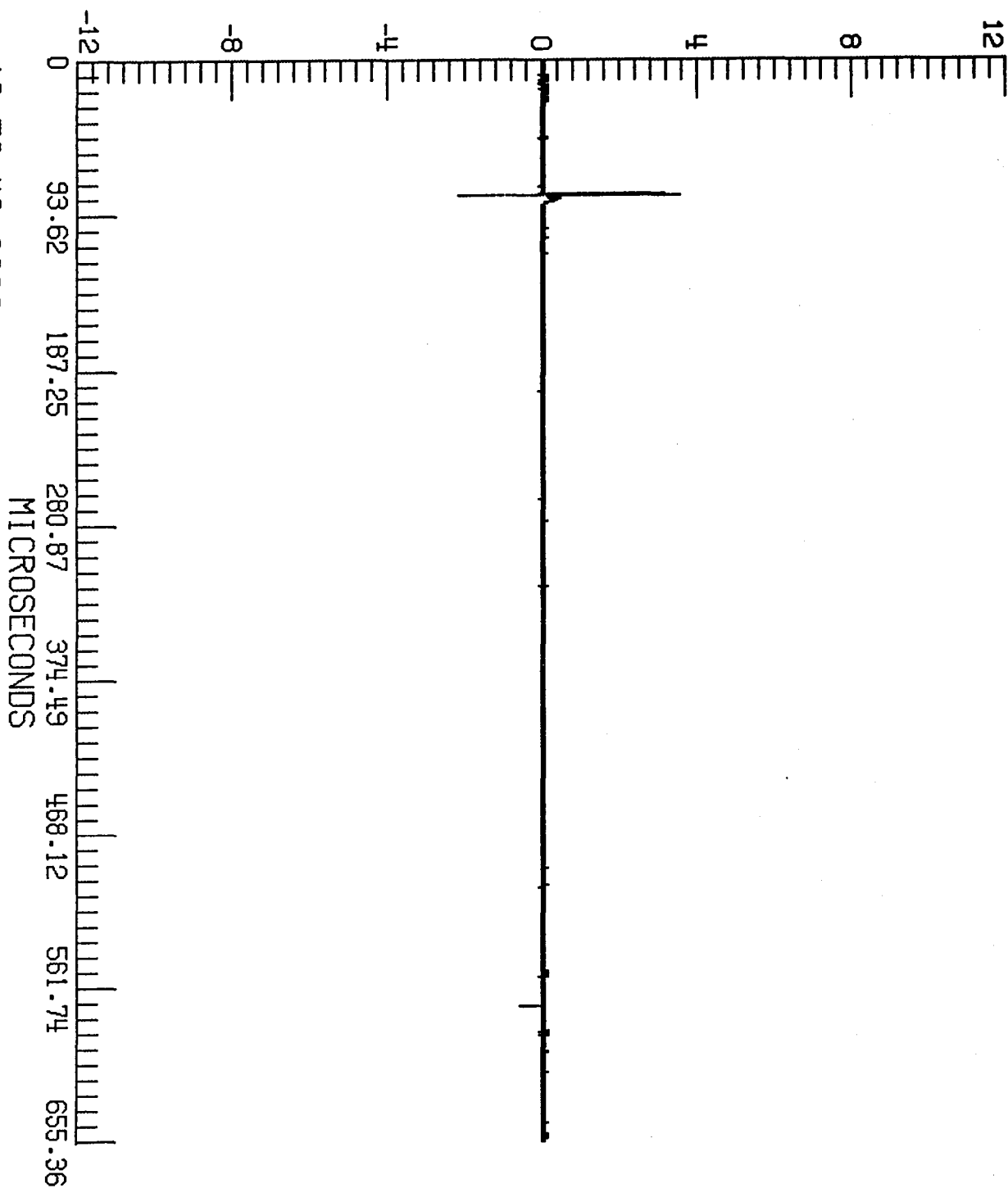
RUN NO. 4 N-003



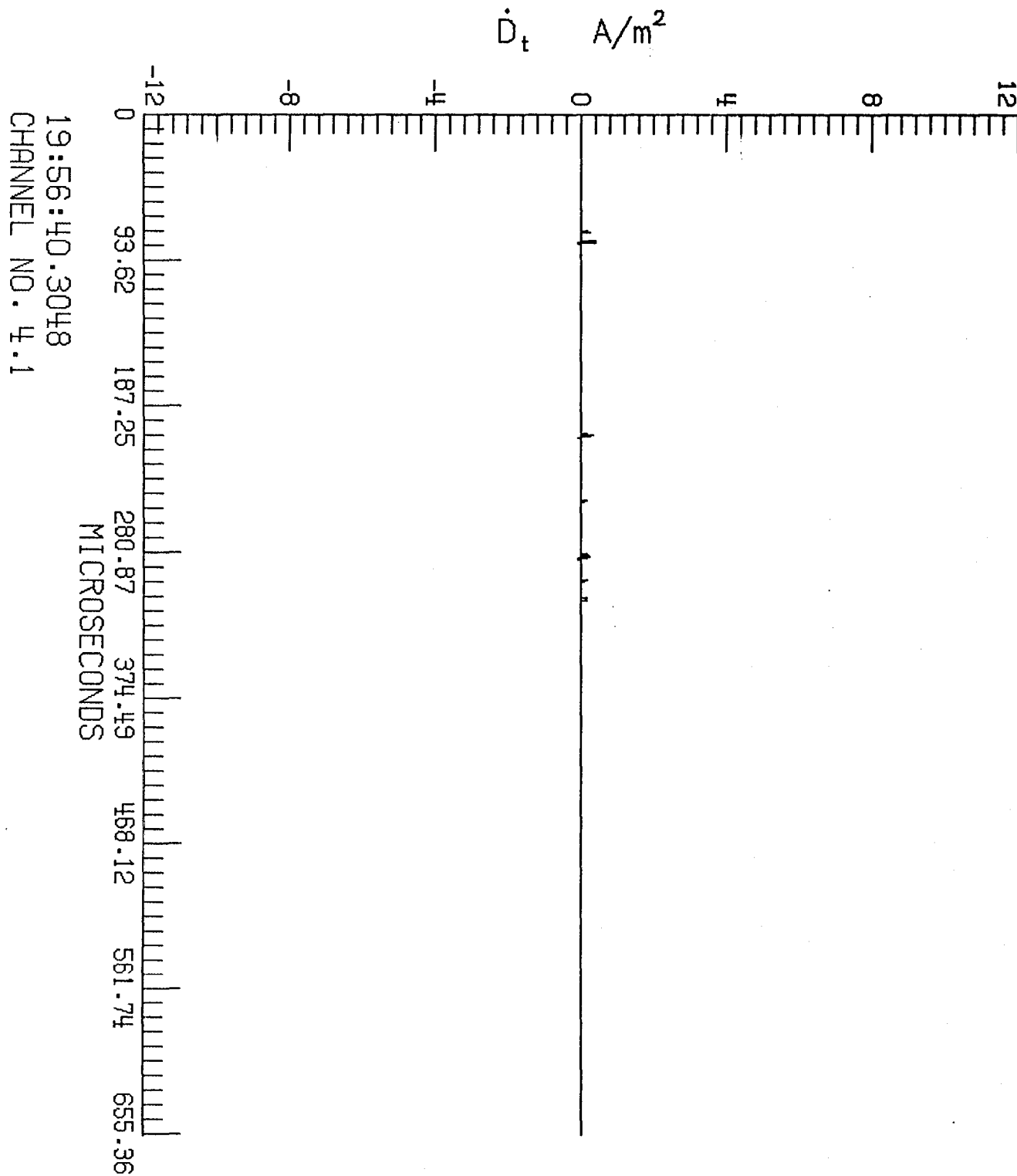


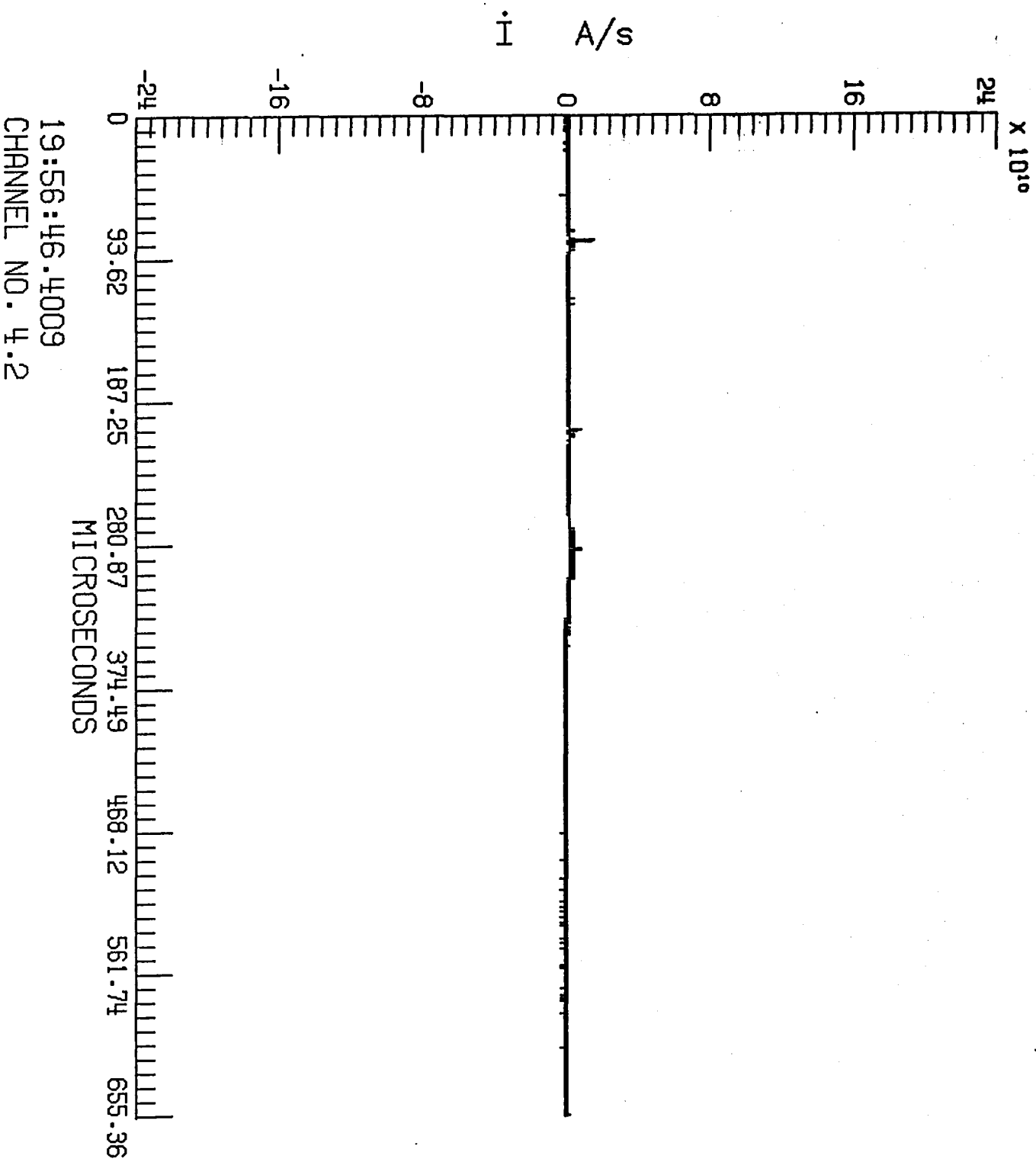
19:56:40.1879
CHANNEL NO. 3.1

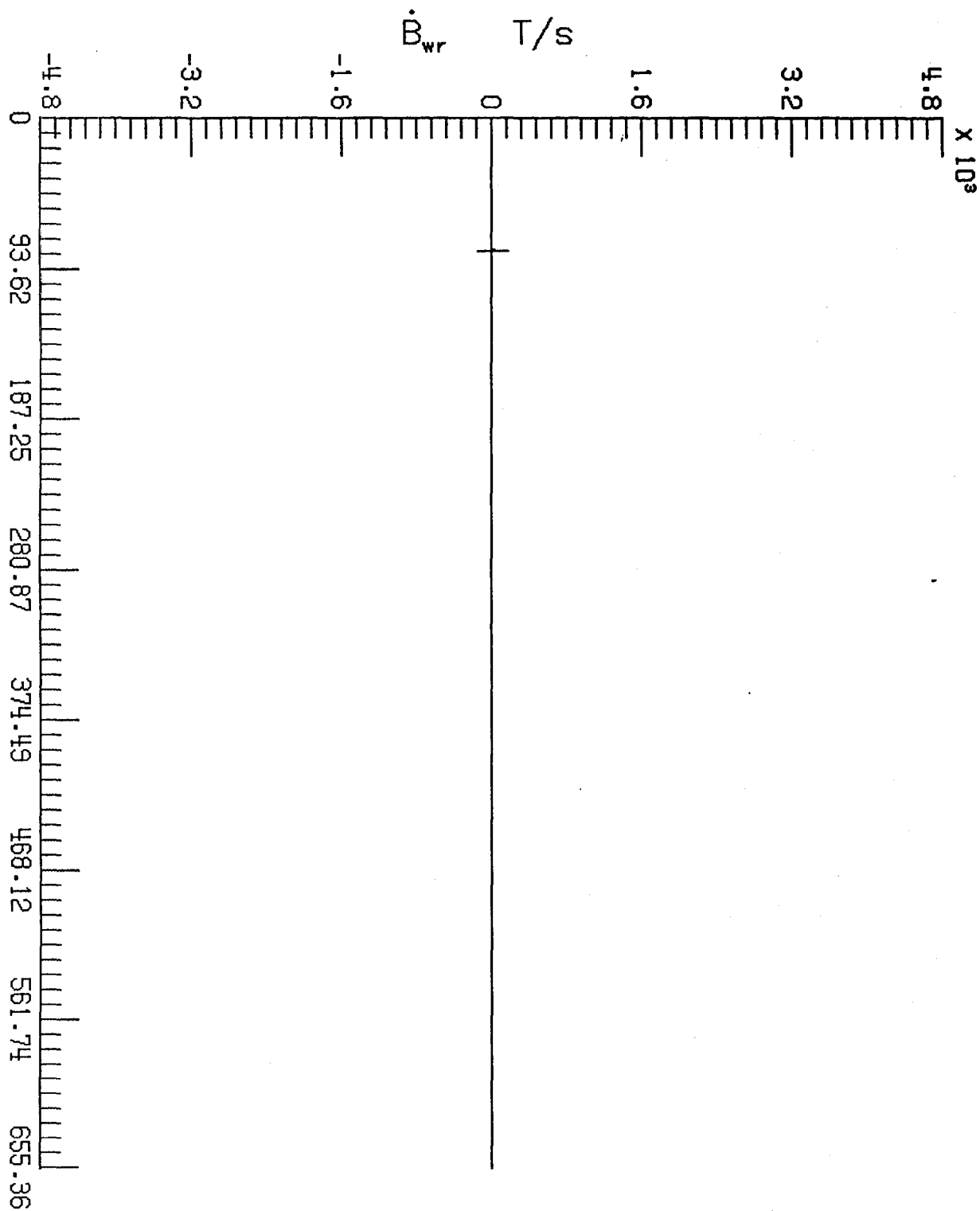
\dot{D}_f A/m²



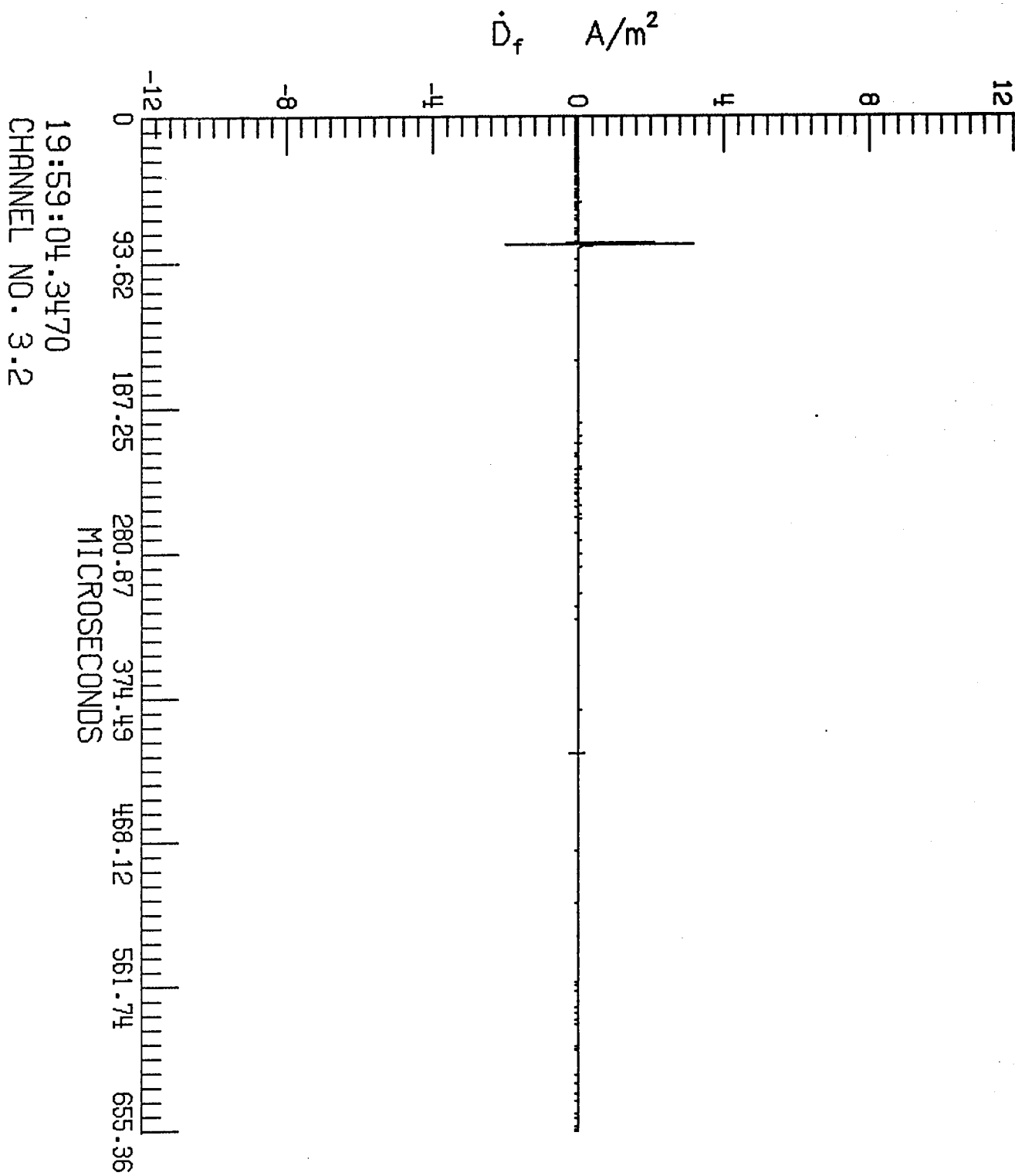
19:56:46.2838
CHANNEL NO. 3.2

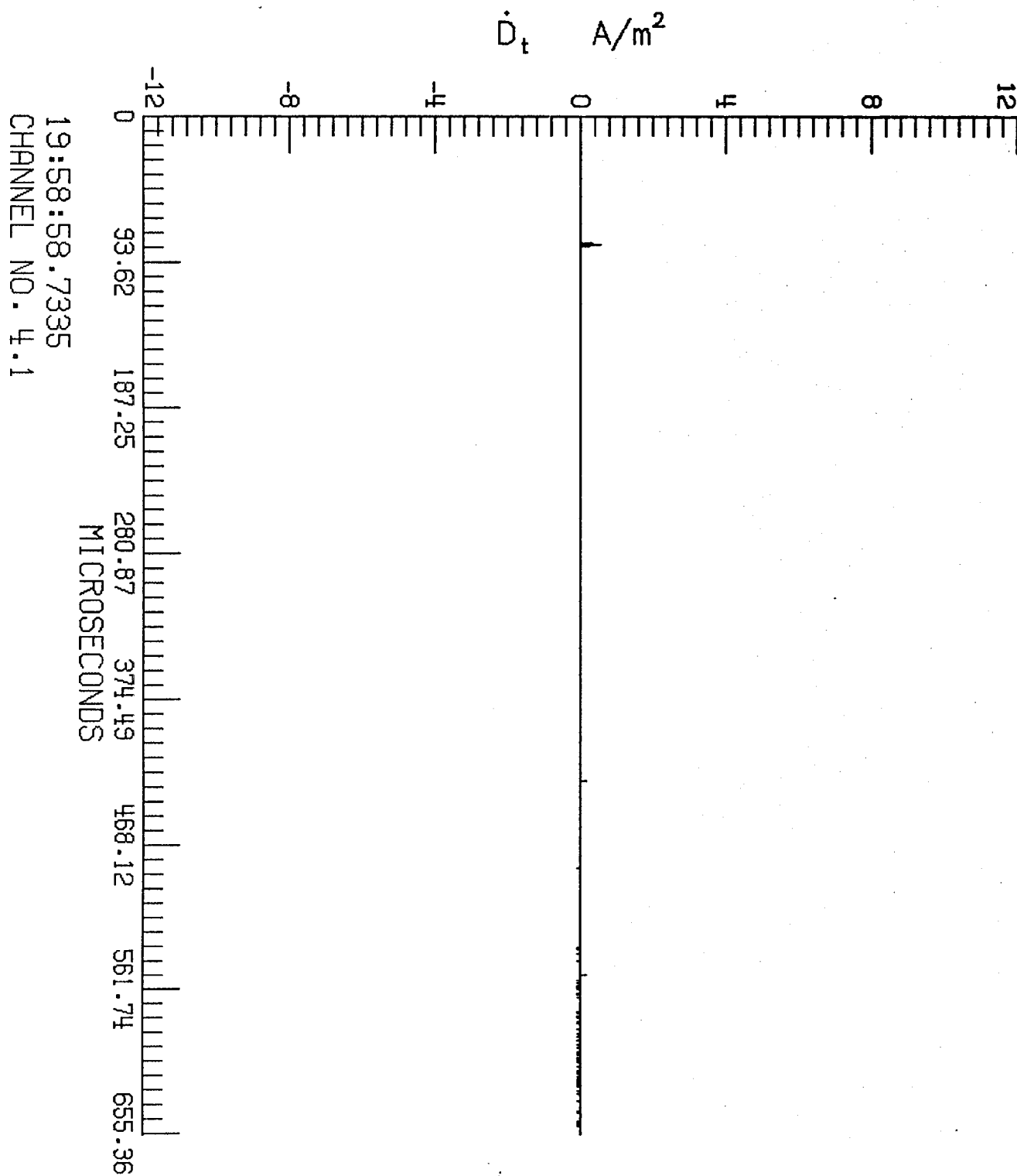


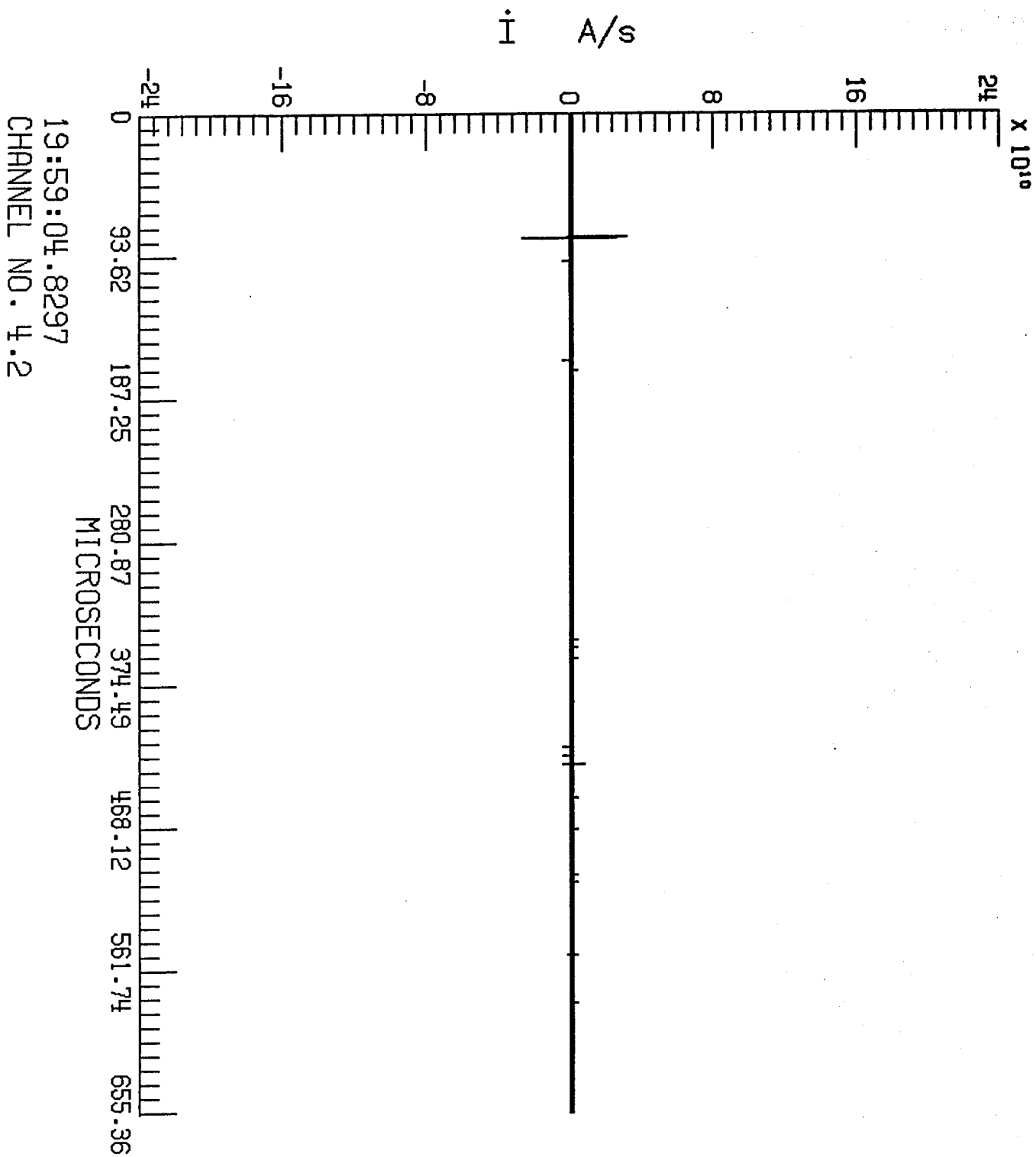




19:58:58.2509
CHANNEL NO. 3.1

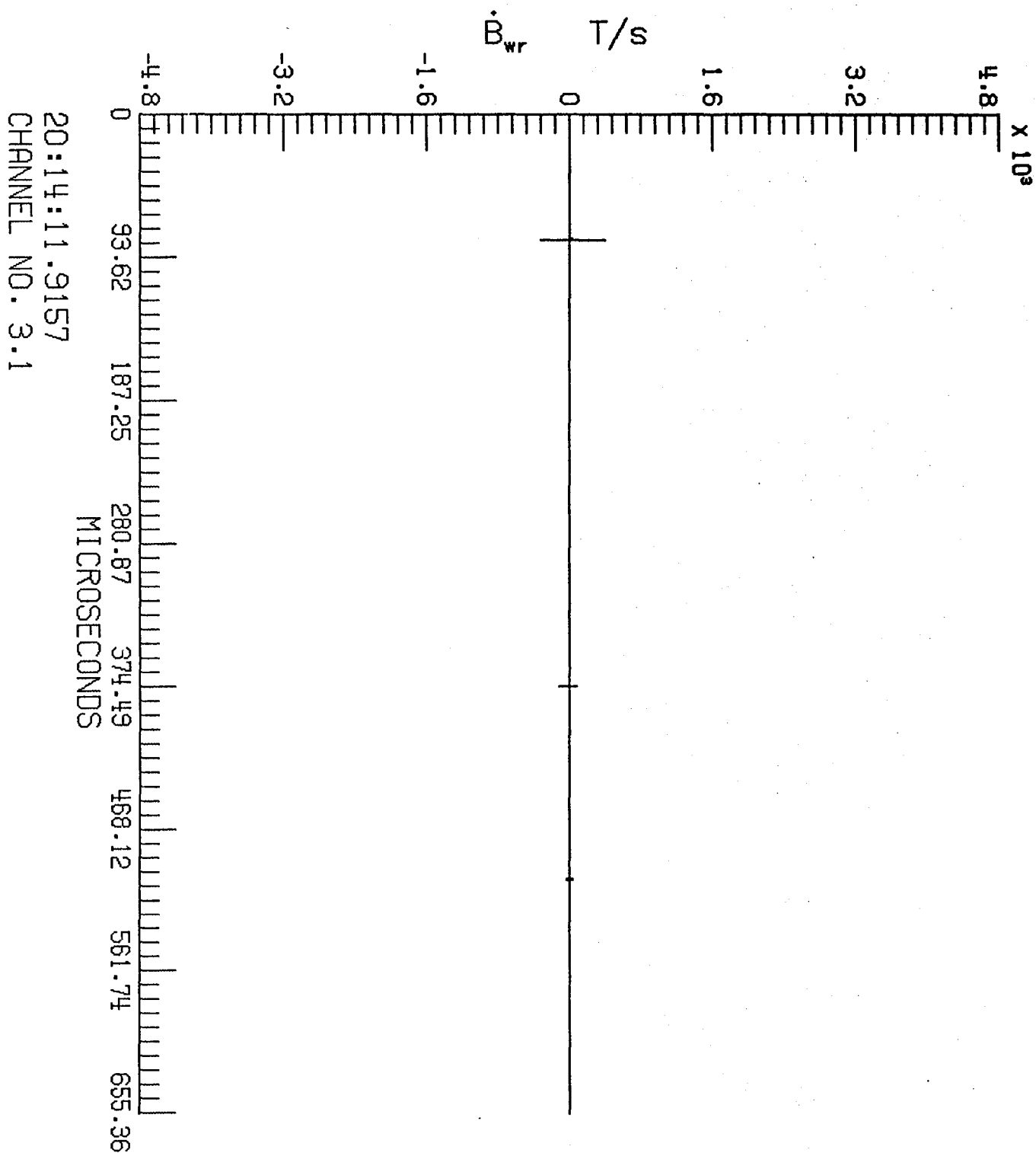


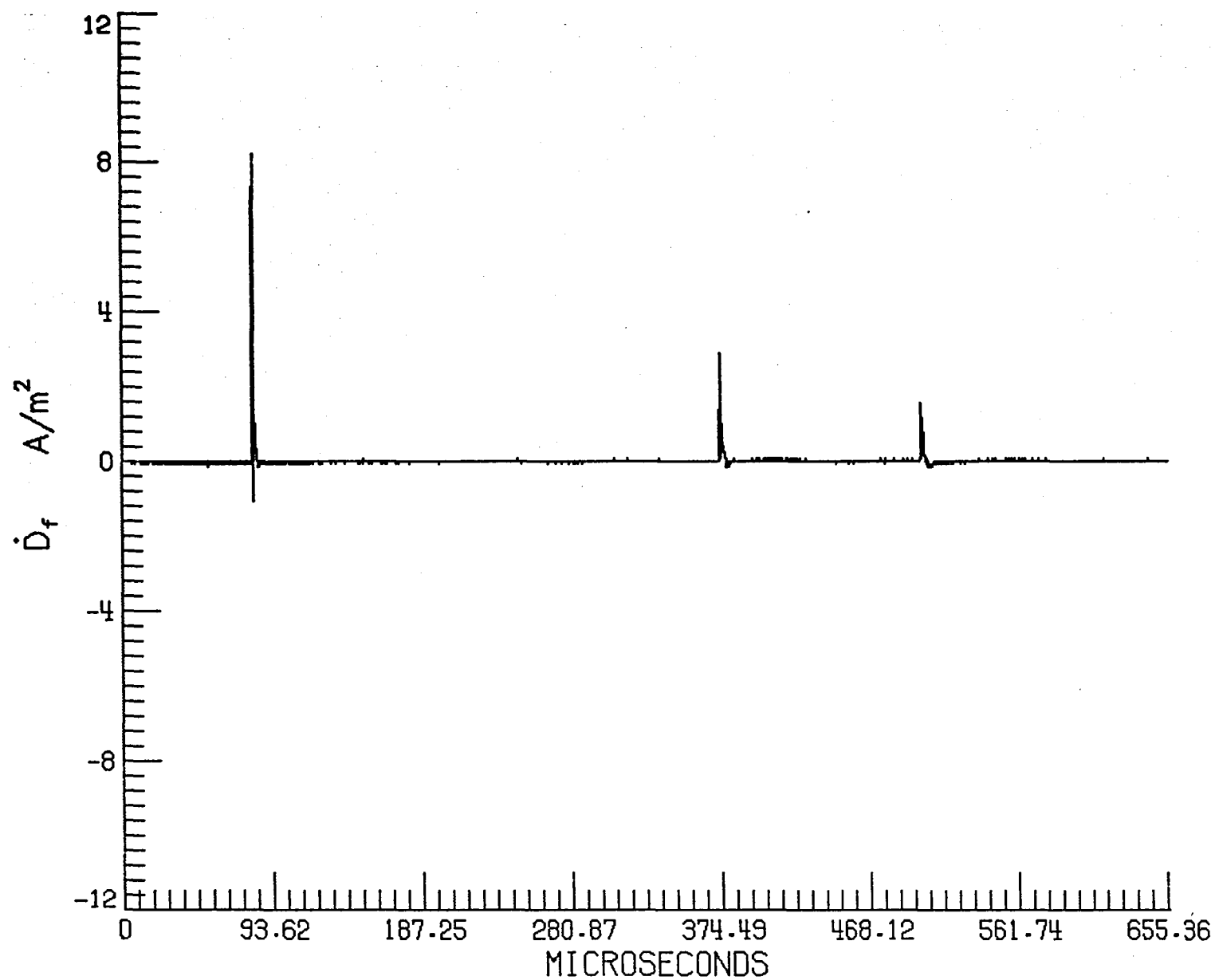




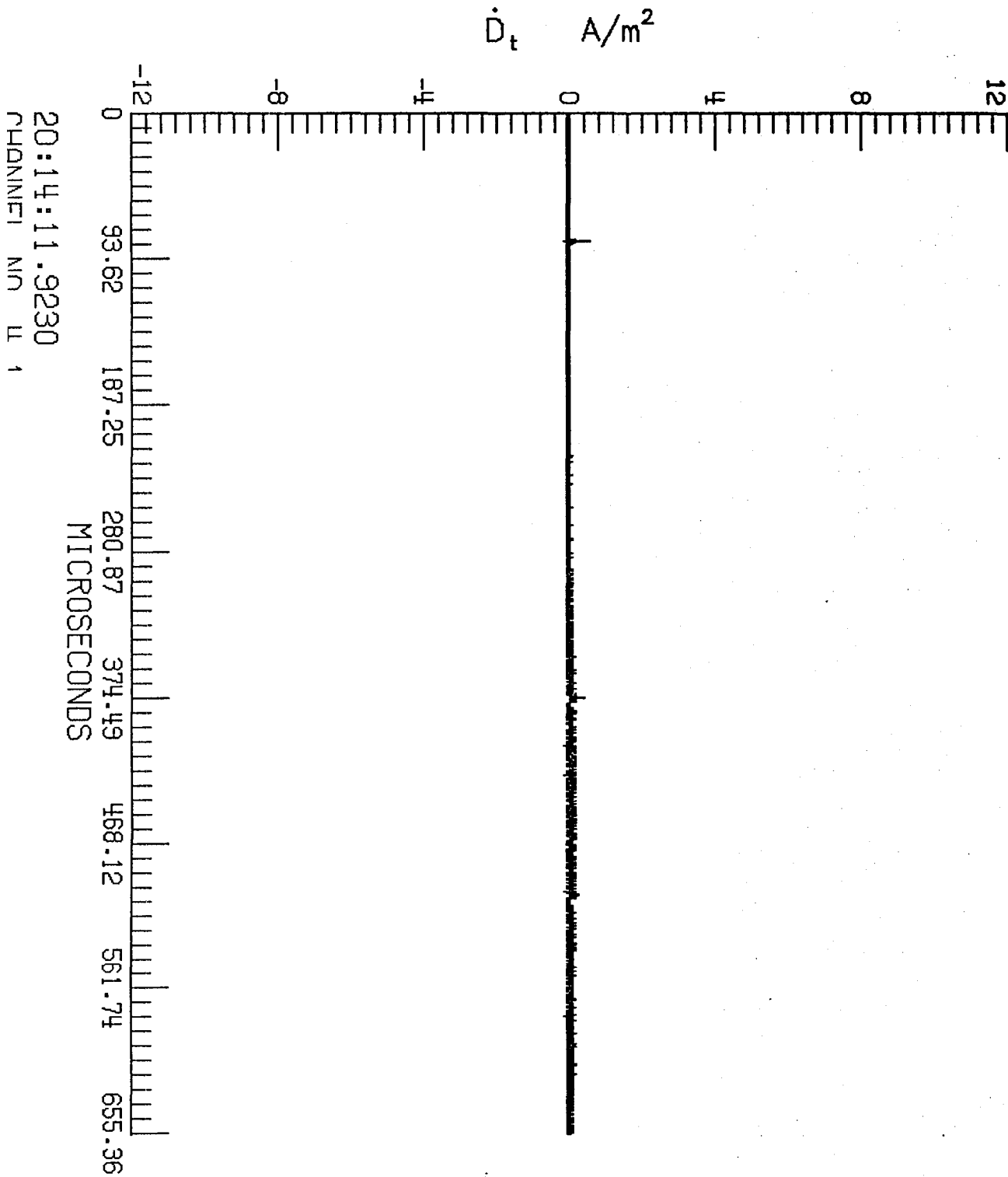
F106 LIGHTNING/TK.4/M.THOMAS

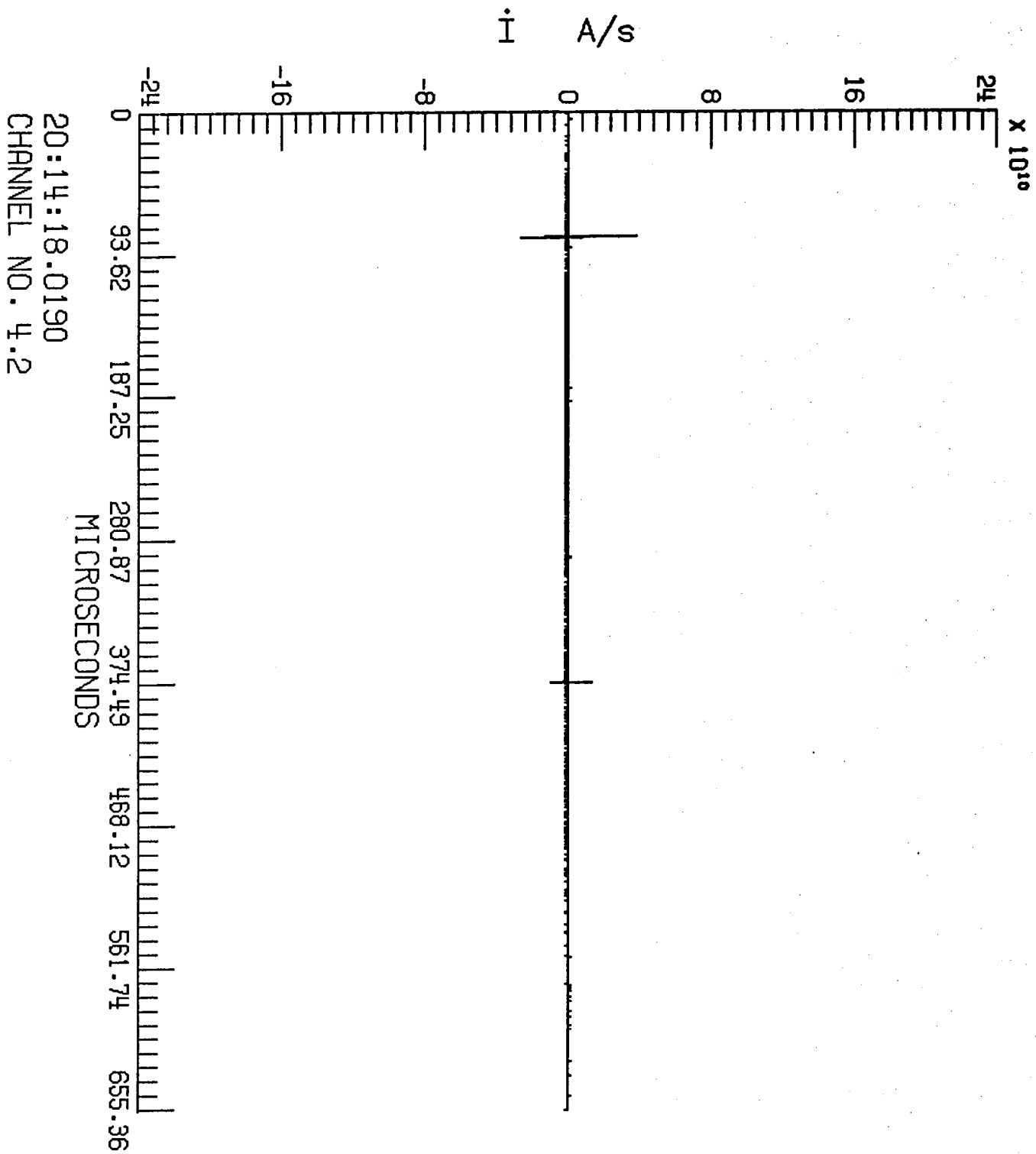
TEST NO. 83-044

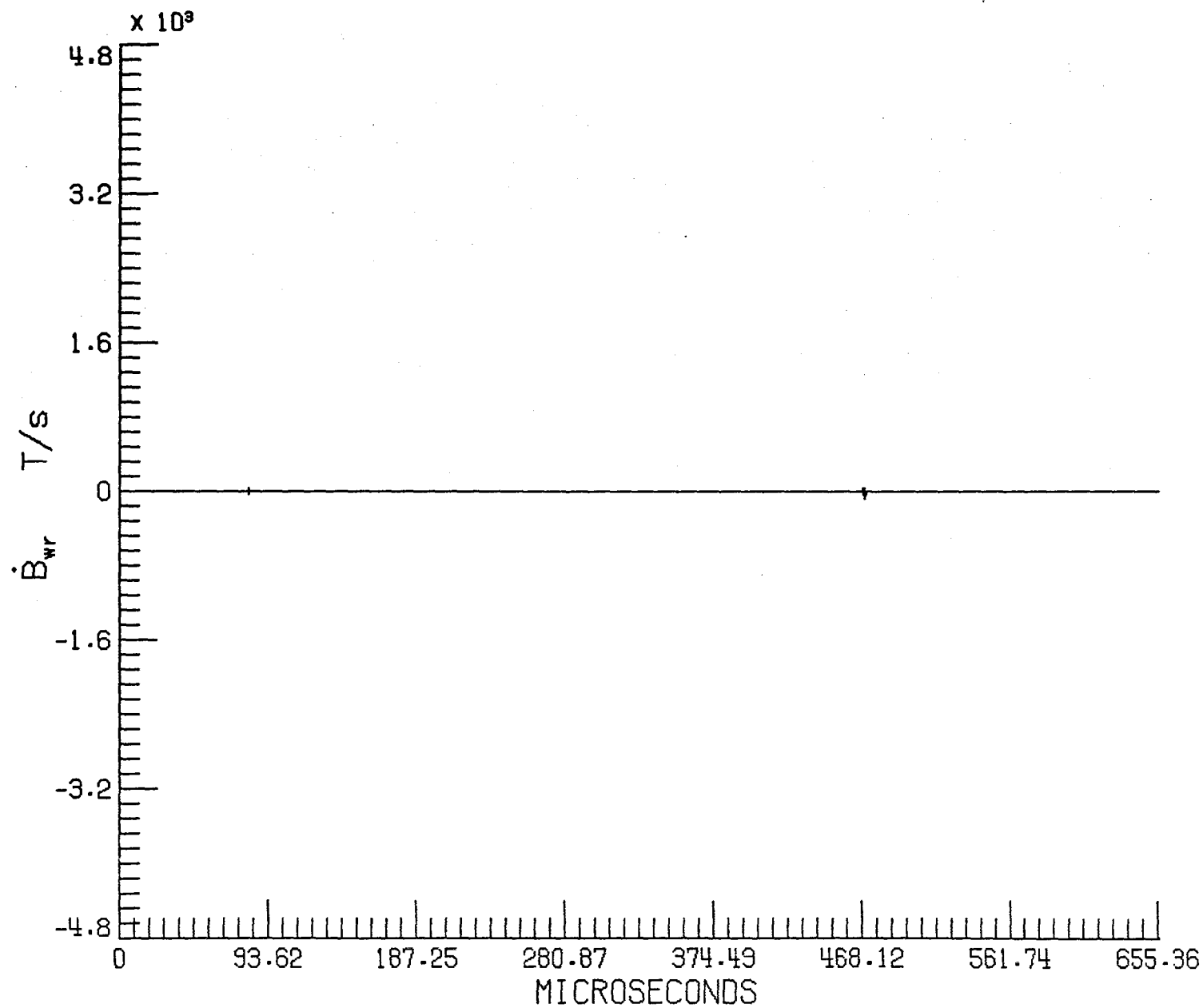




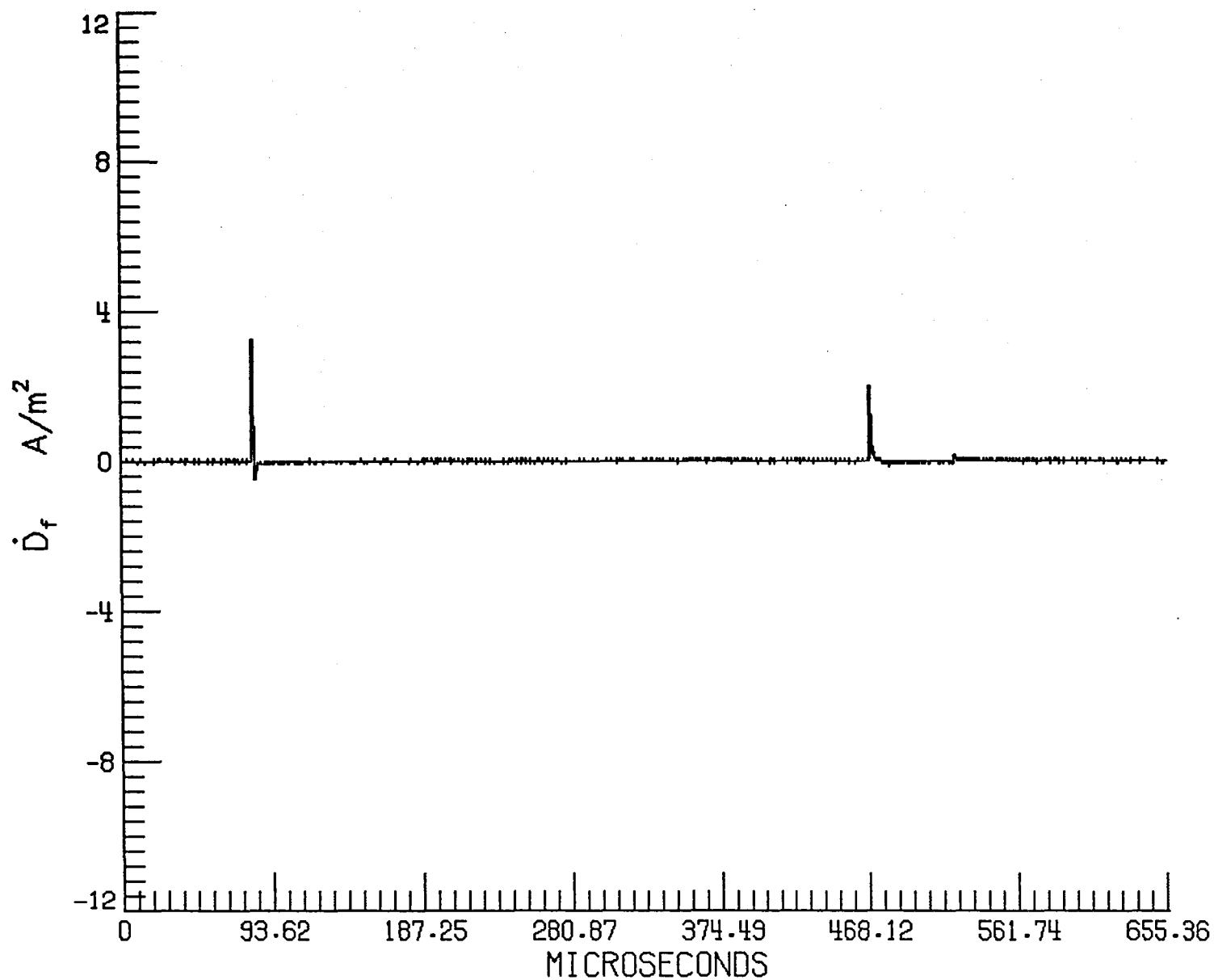
20:14:18.0119
CHANNEL NO. 3.2



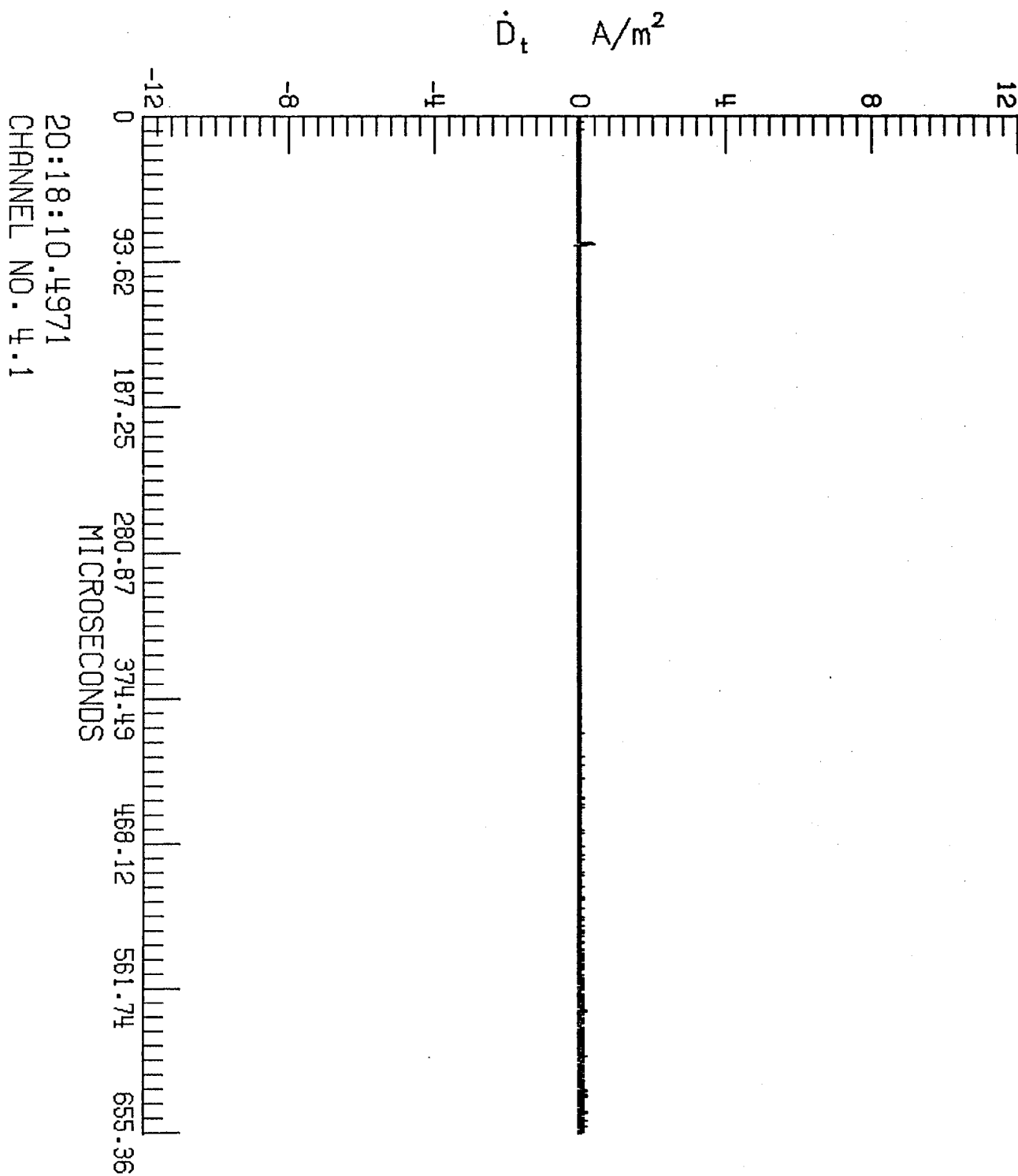


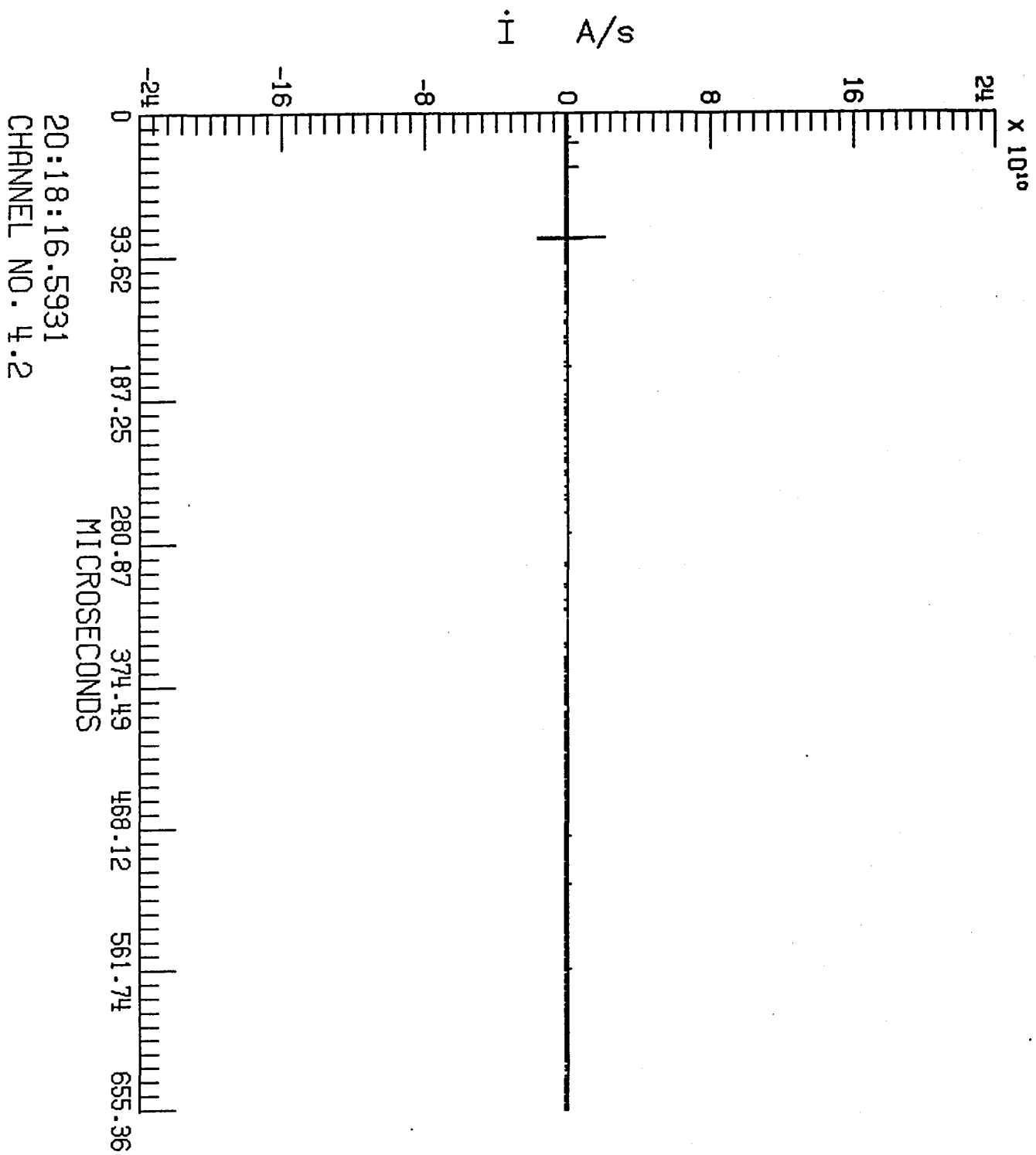


20:18:15.7712
CHANNEL NO. 3.1



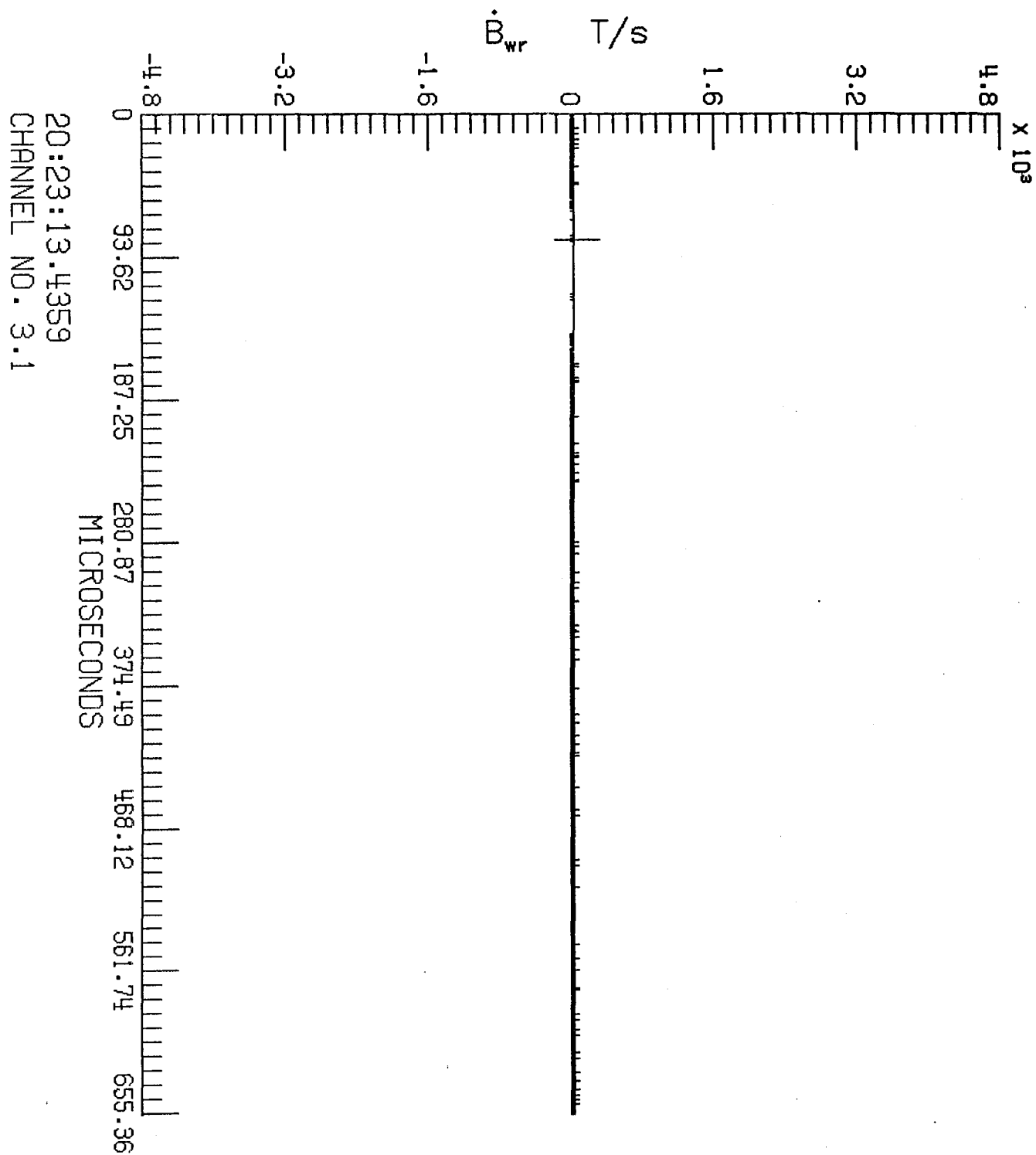
20:18:21.8672
CHANNEL NO. 3.2

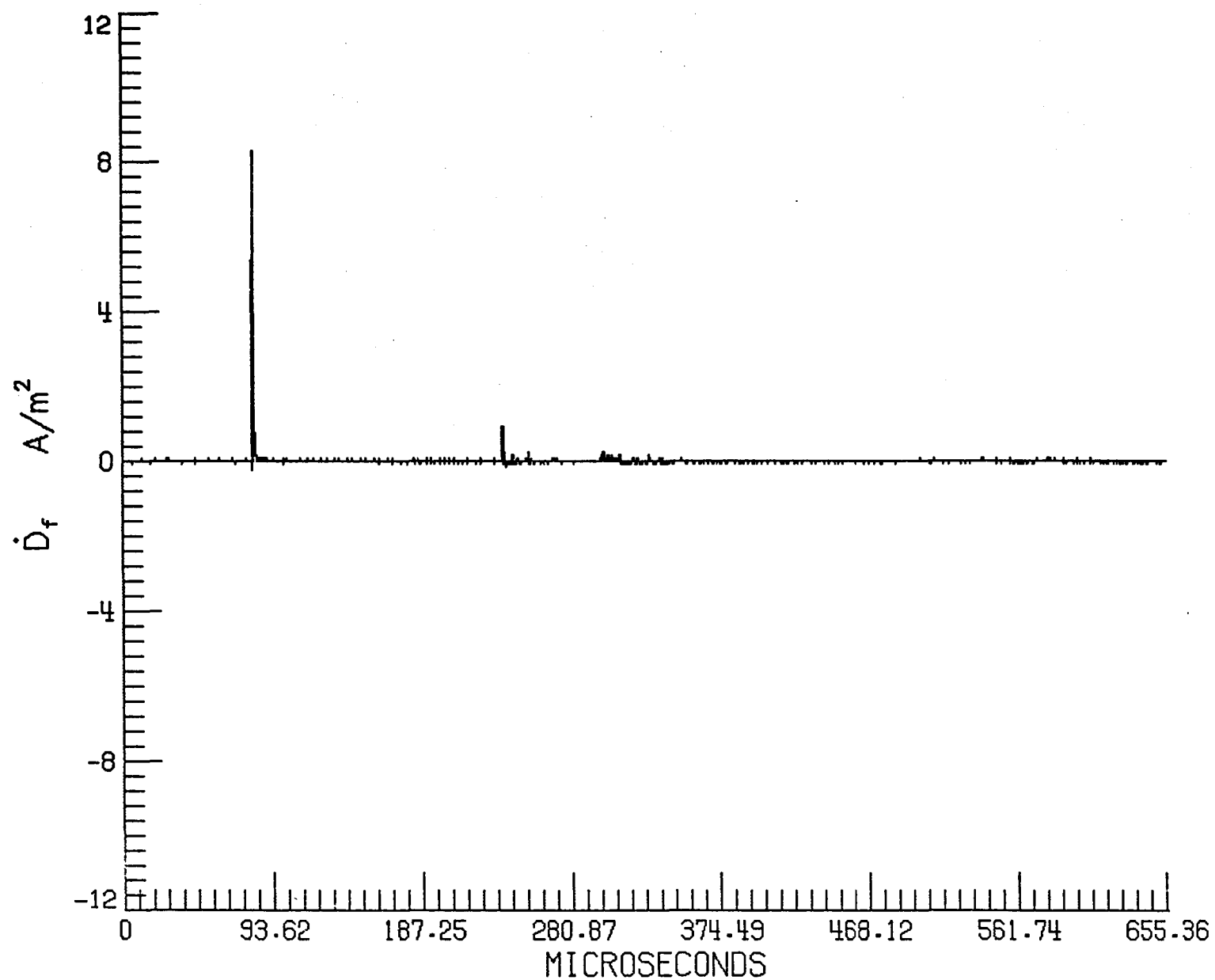




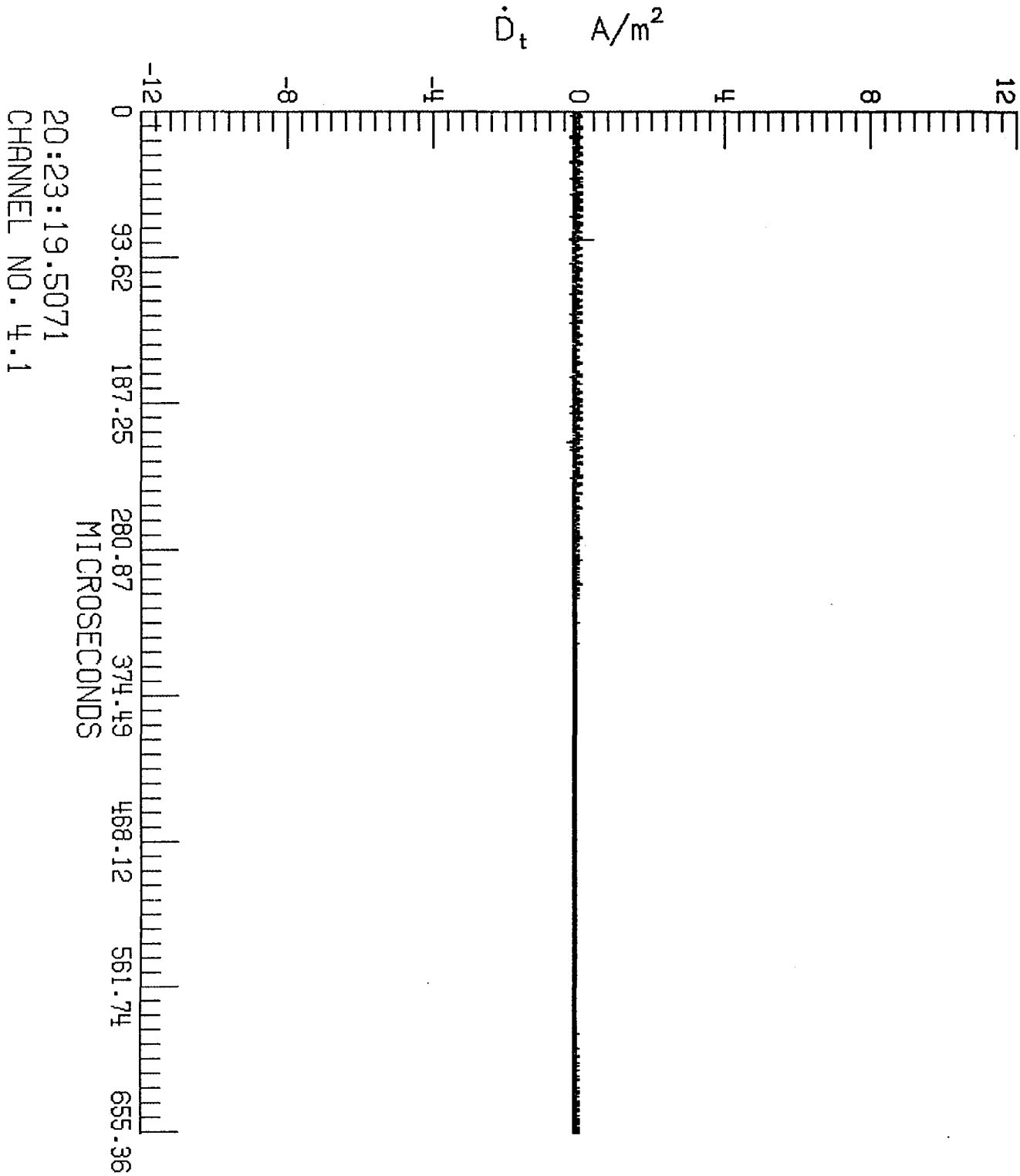
F106 LIGHTNING/TK.4/M.THOMAS

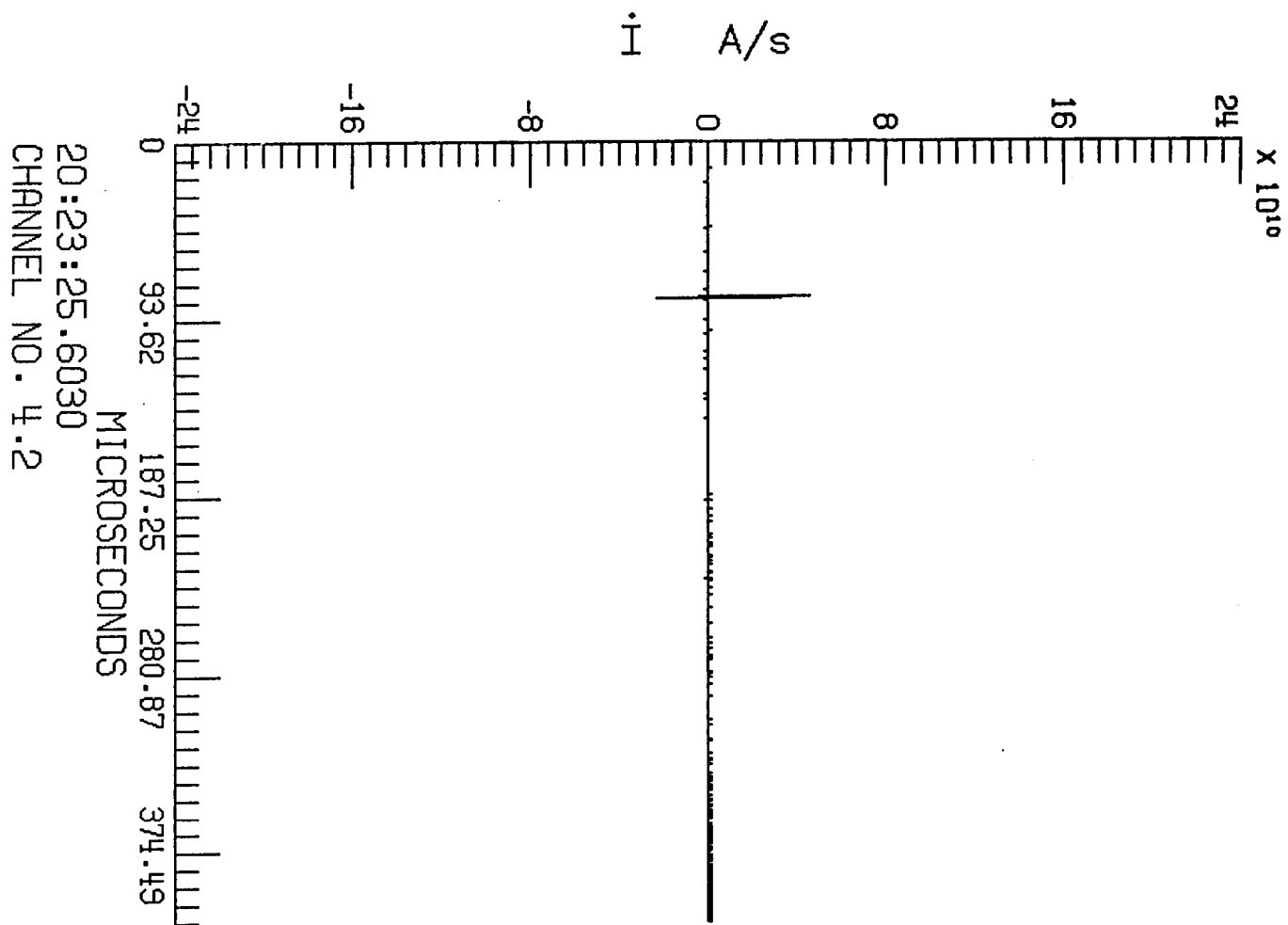
TEST NO. 83-044

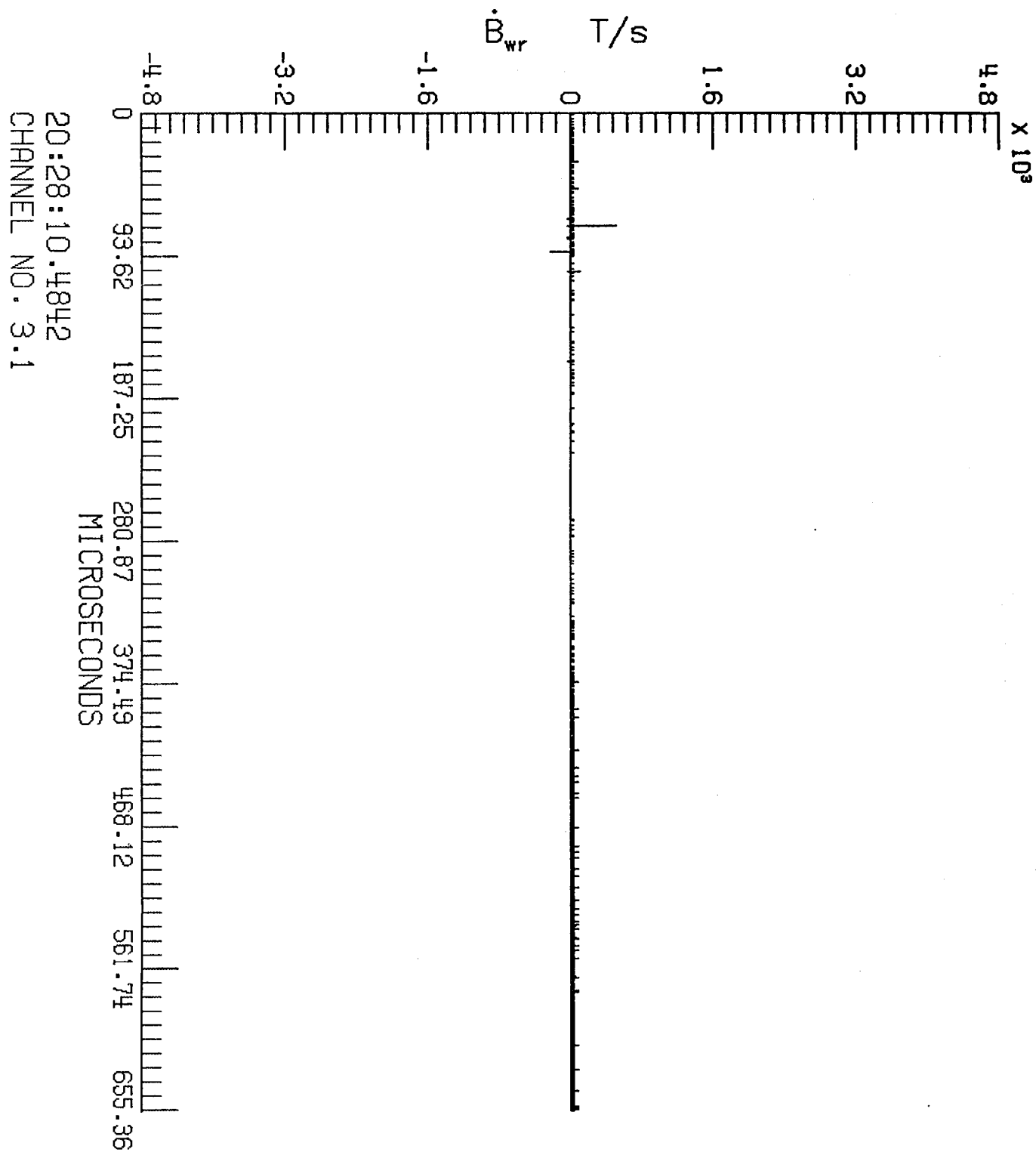


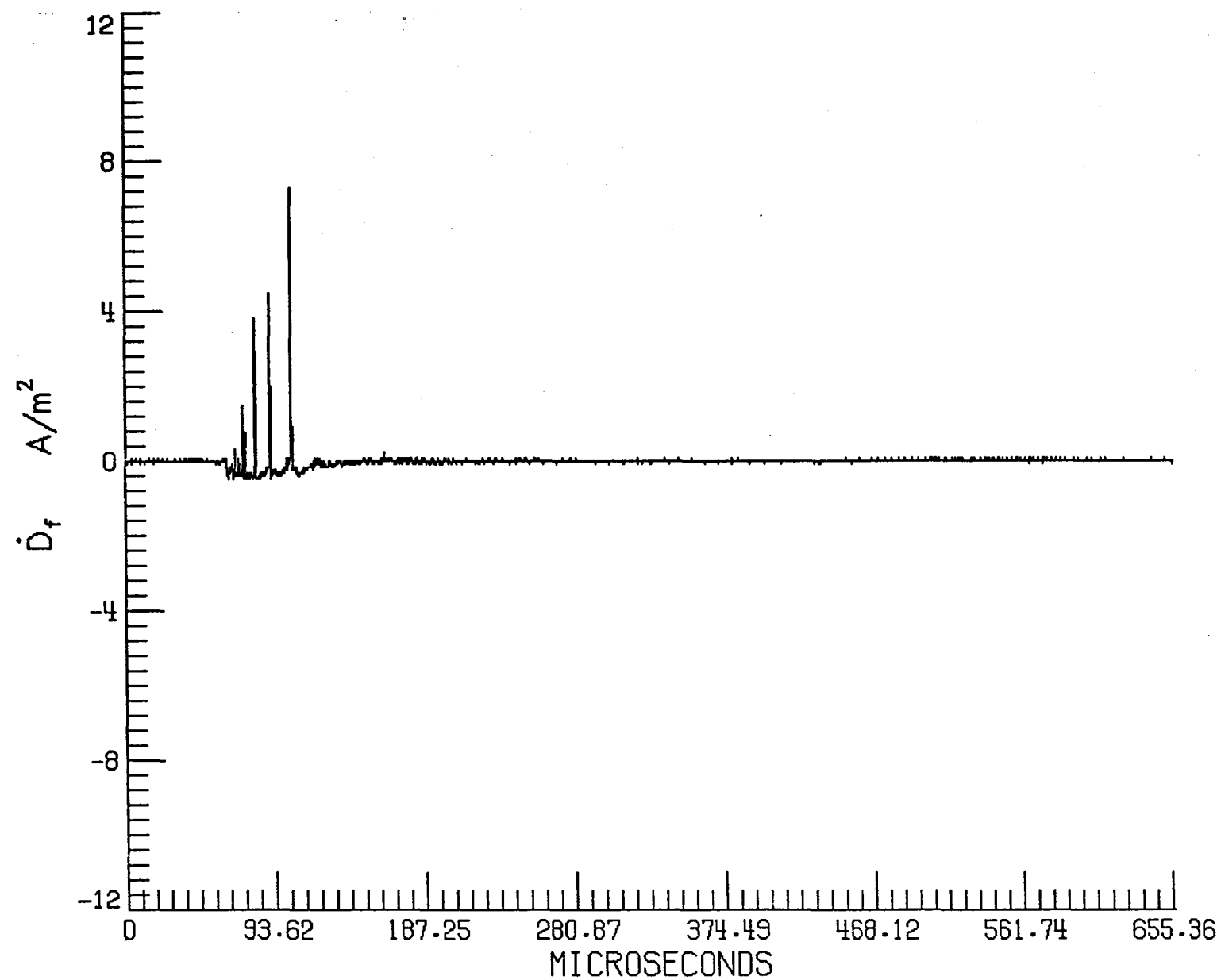


20:23:19.5320
CHANNEL NO. 3.2



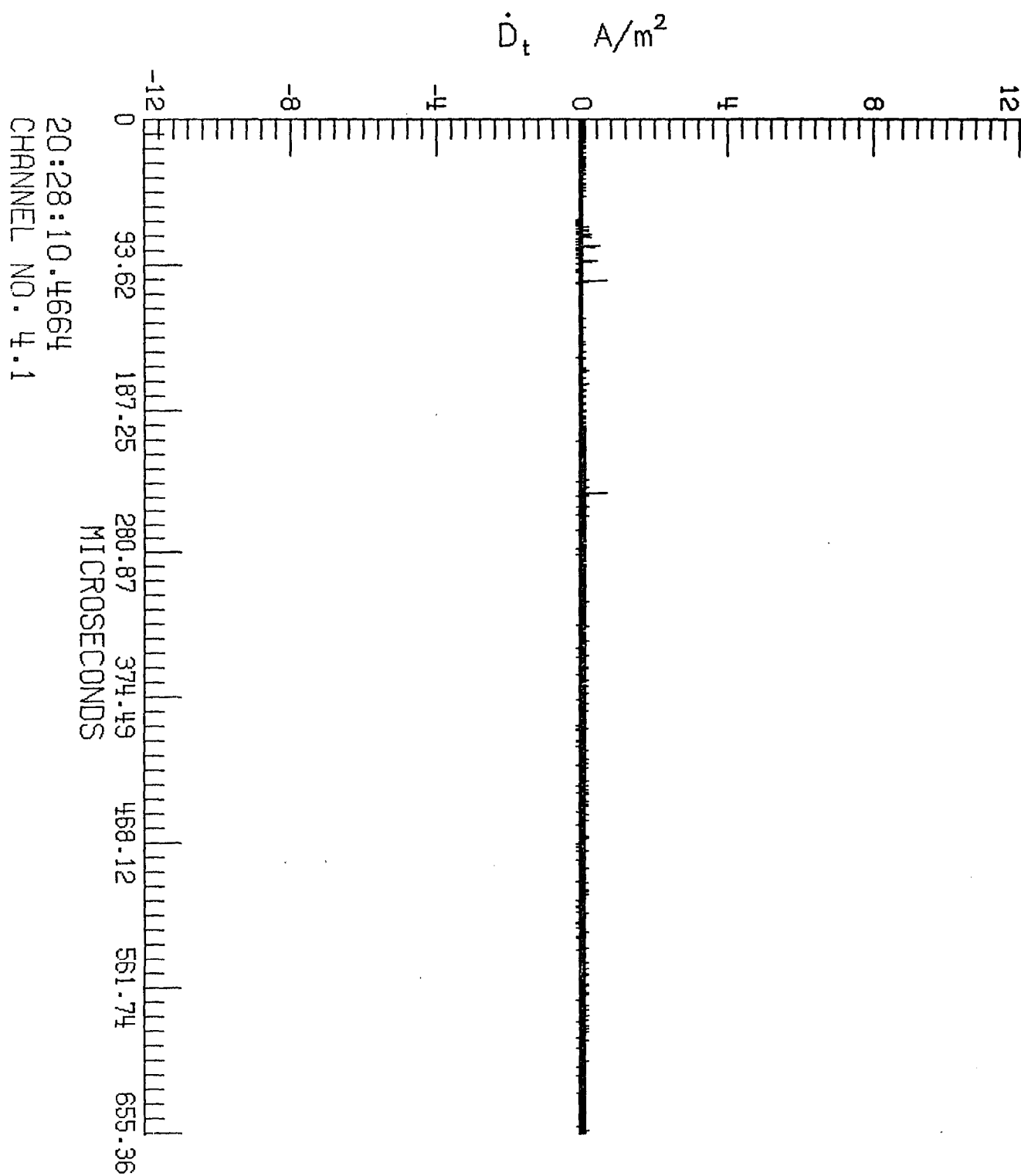


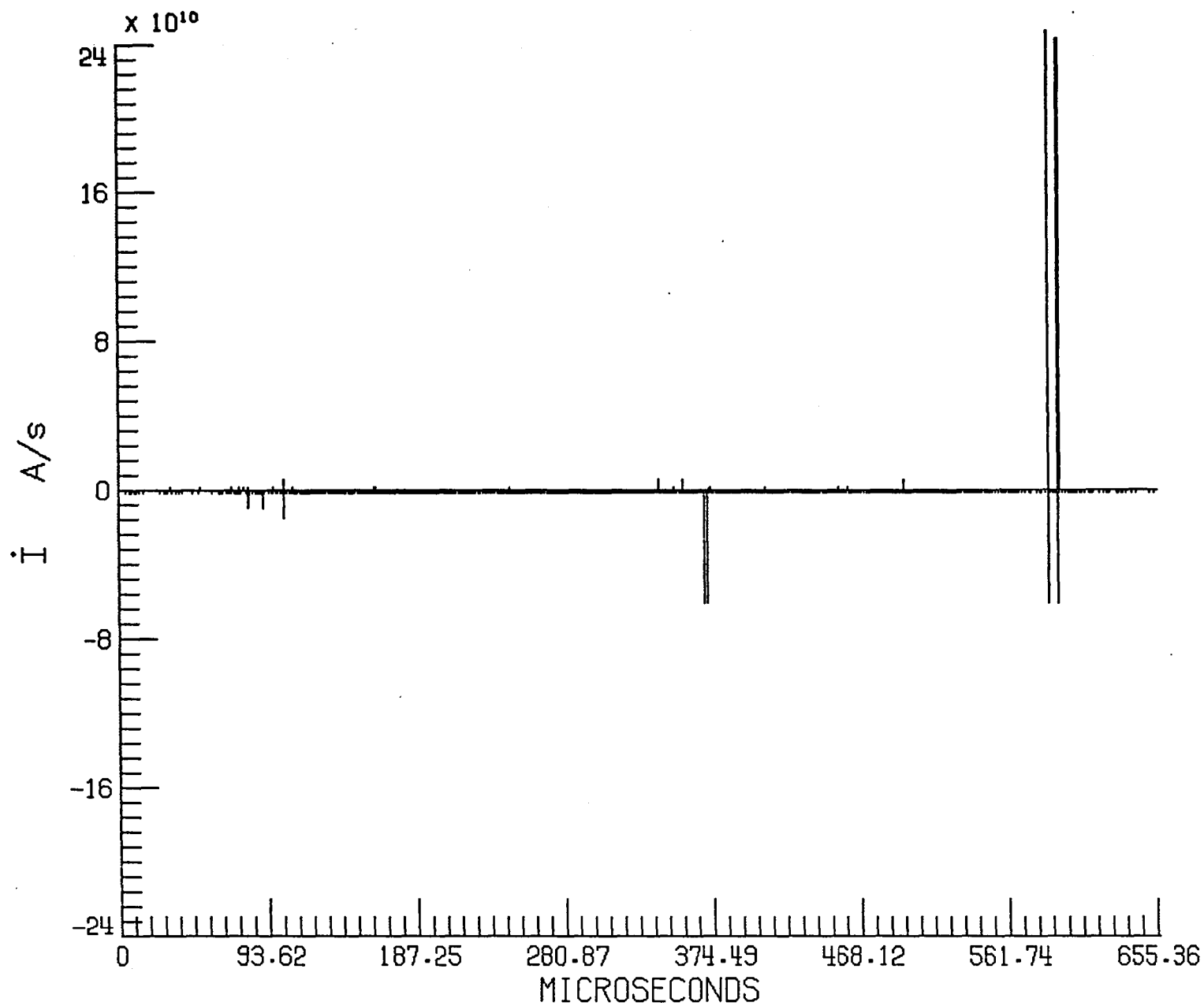




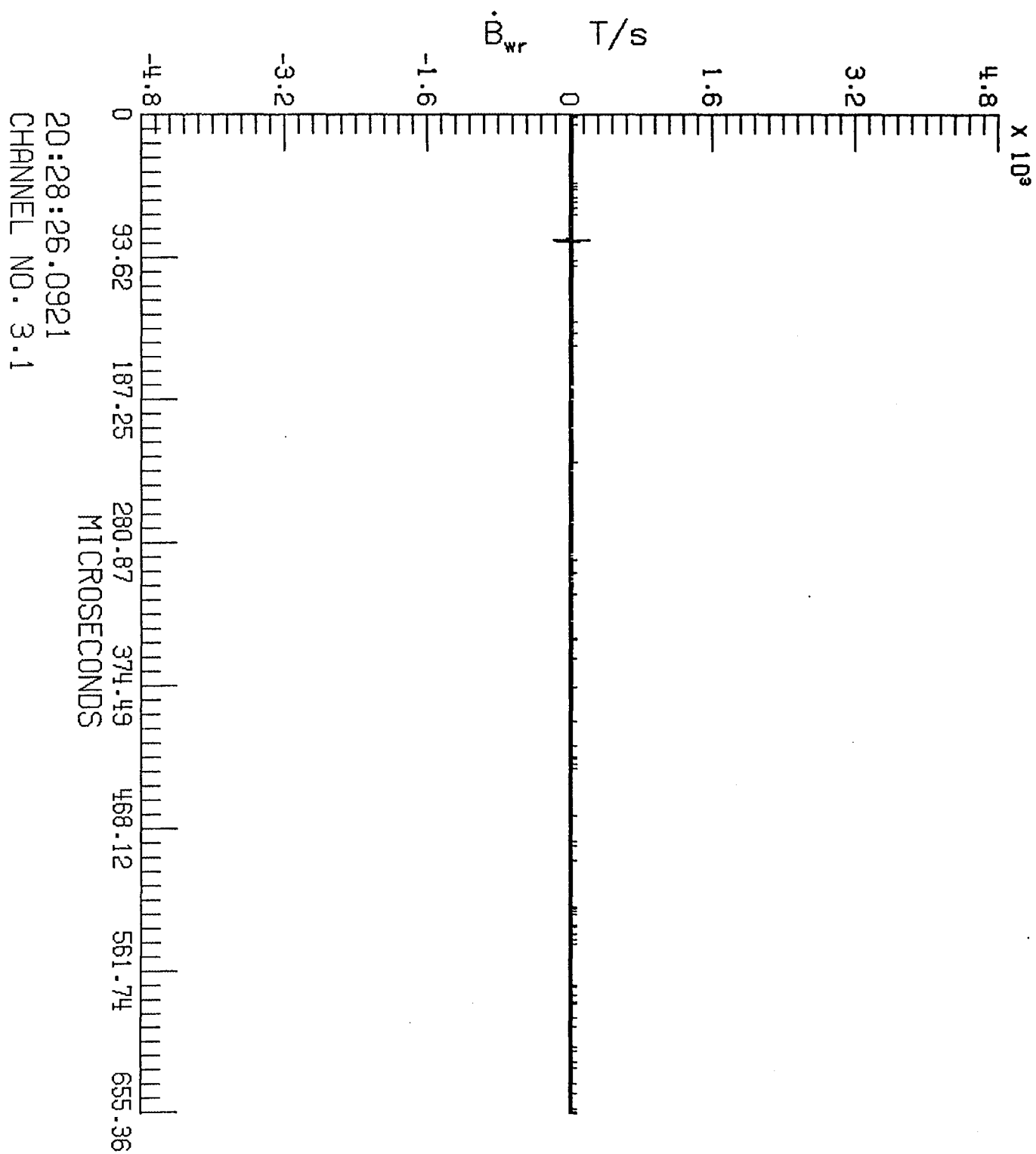
20:28:16.5803

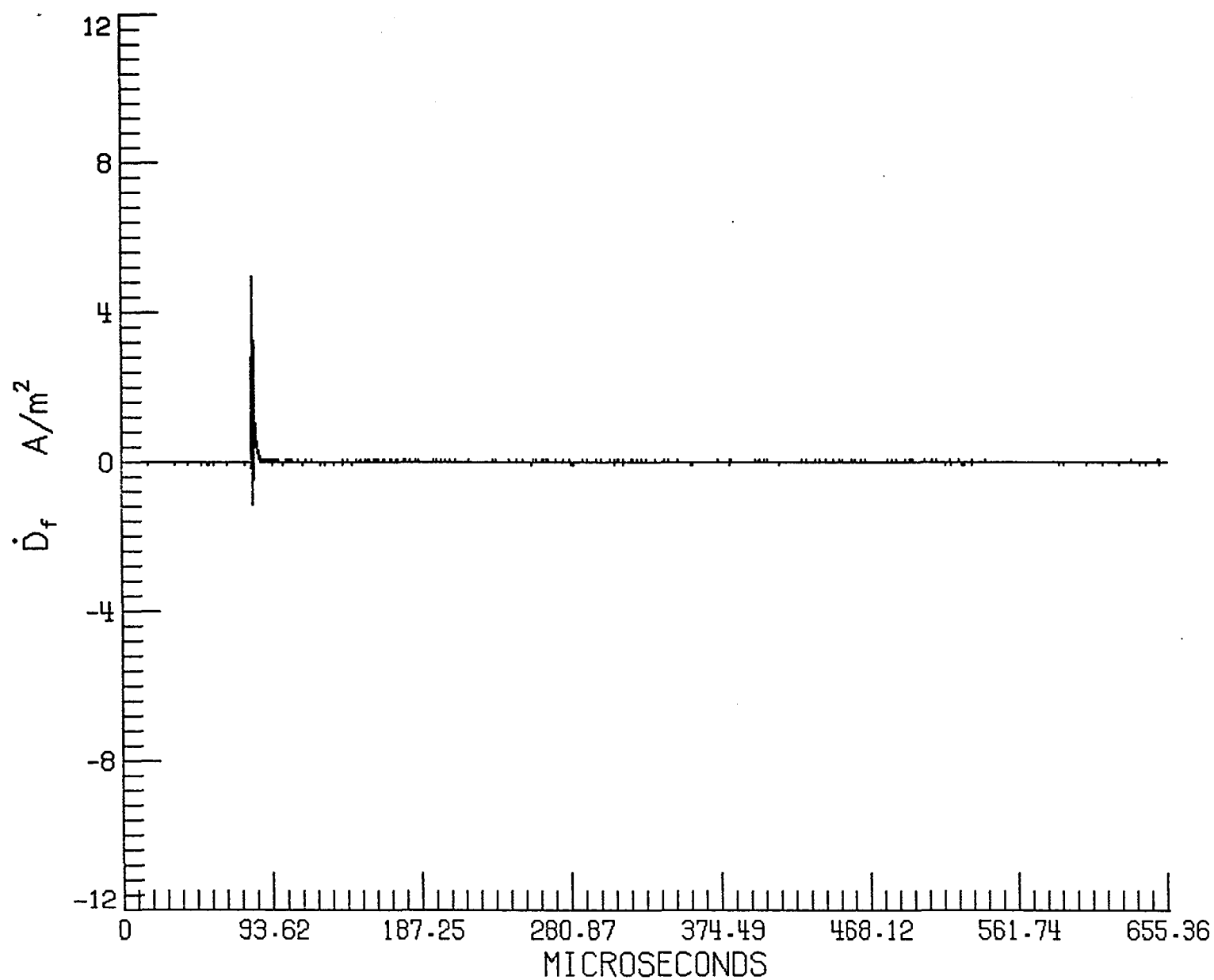
CHANNEL NO. 3.2



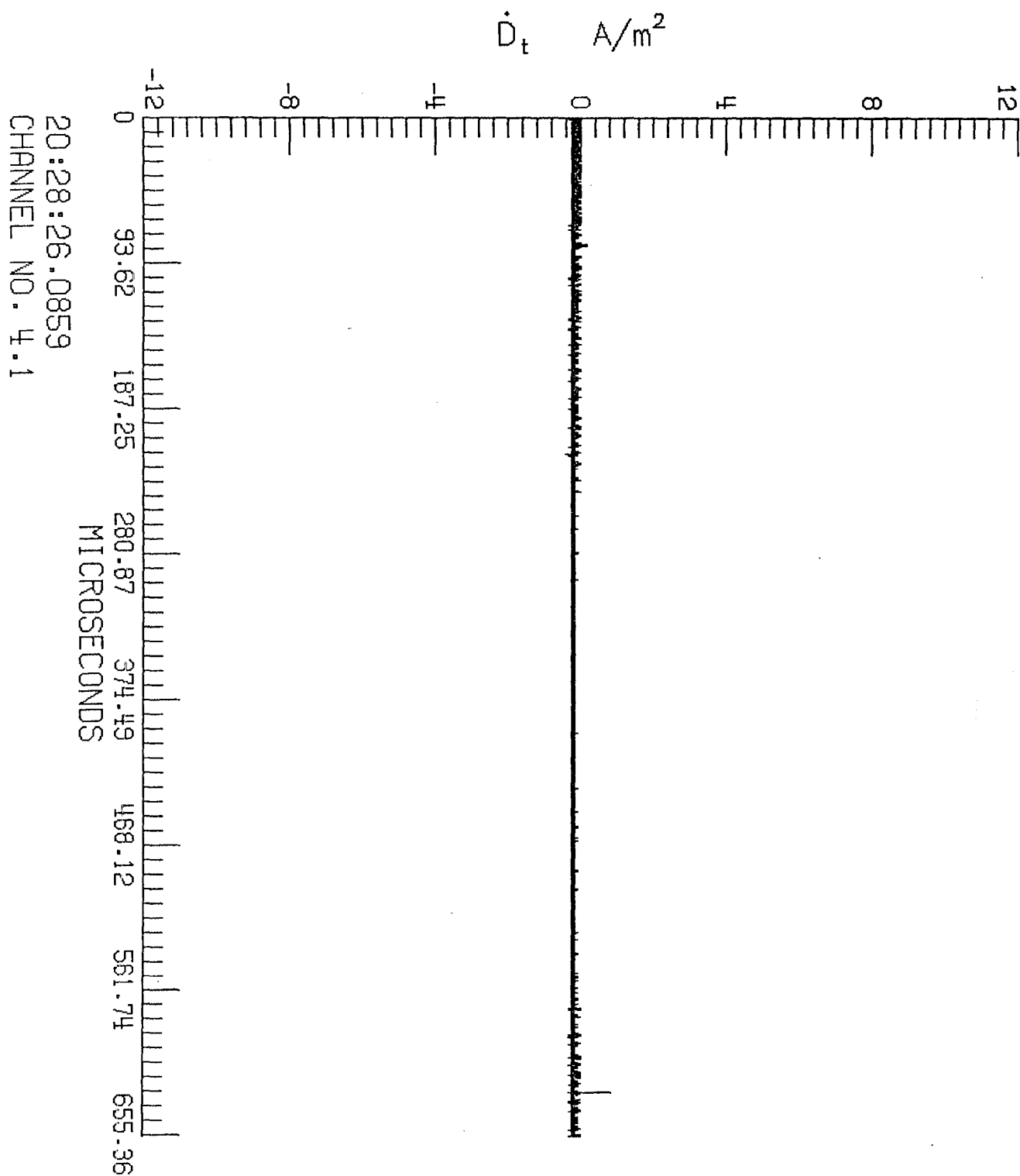


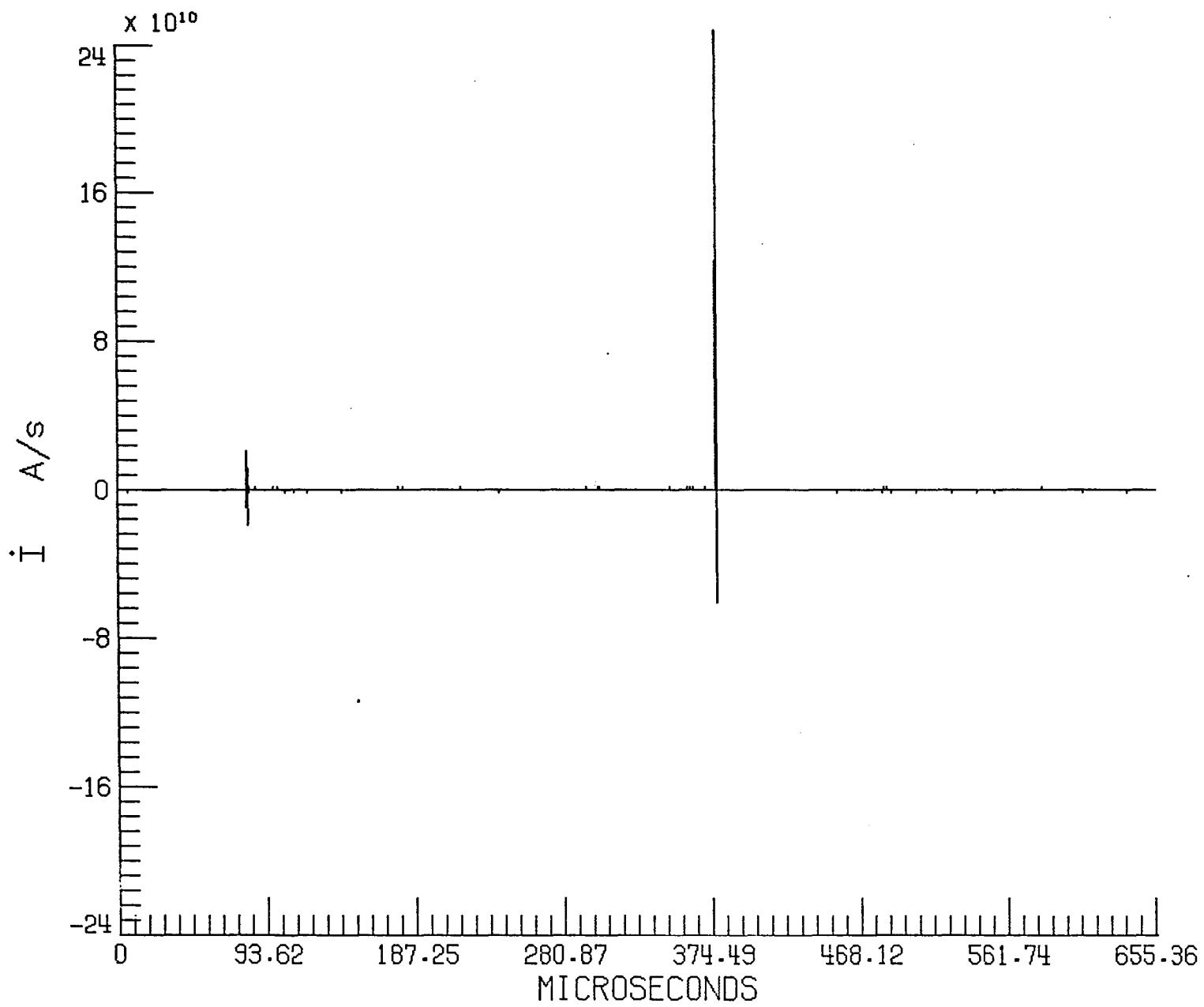
20:28:16.5623
CHANNEL NO. 4.2





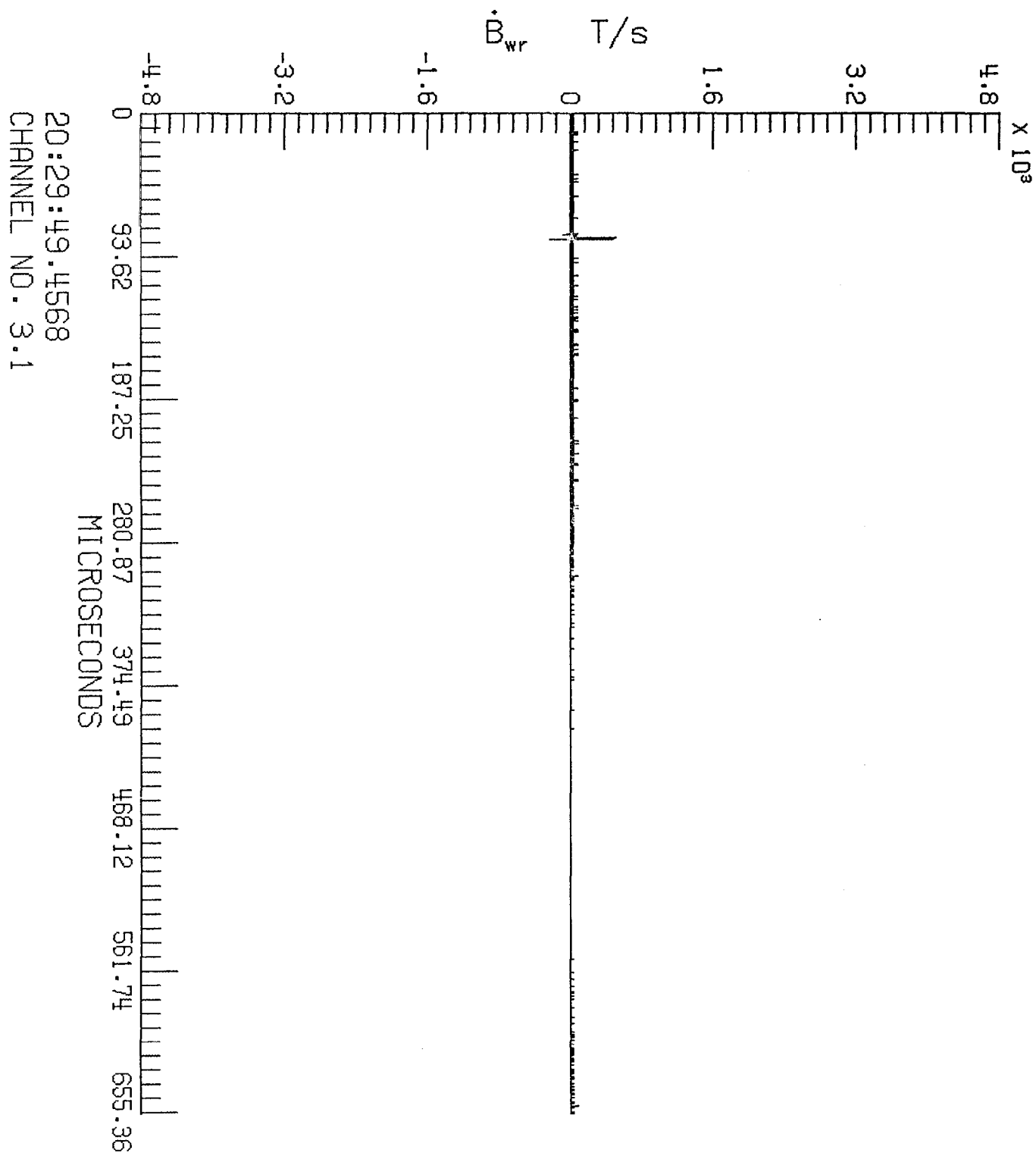
20:28:32.1882
CHANNEL NO. 3.2

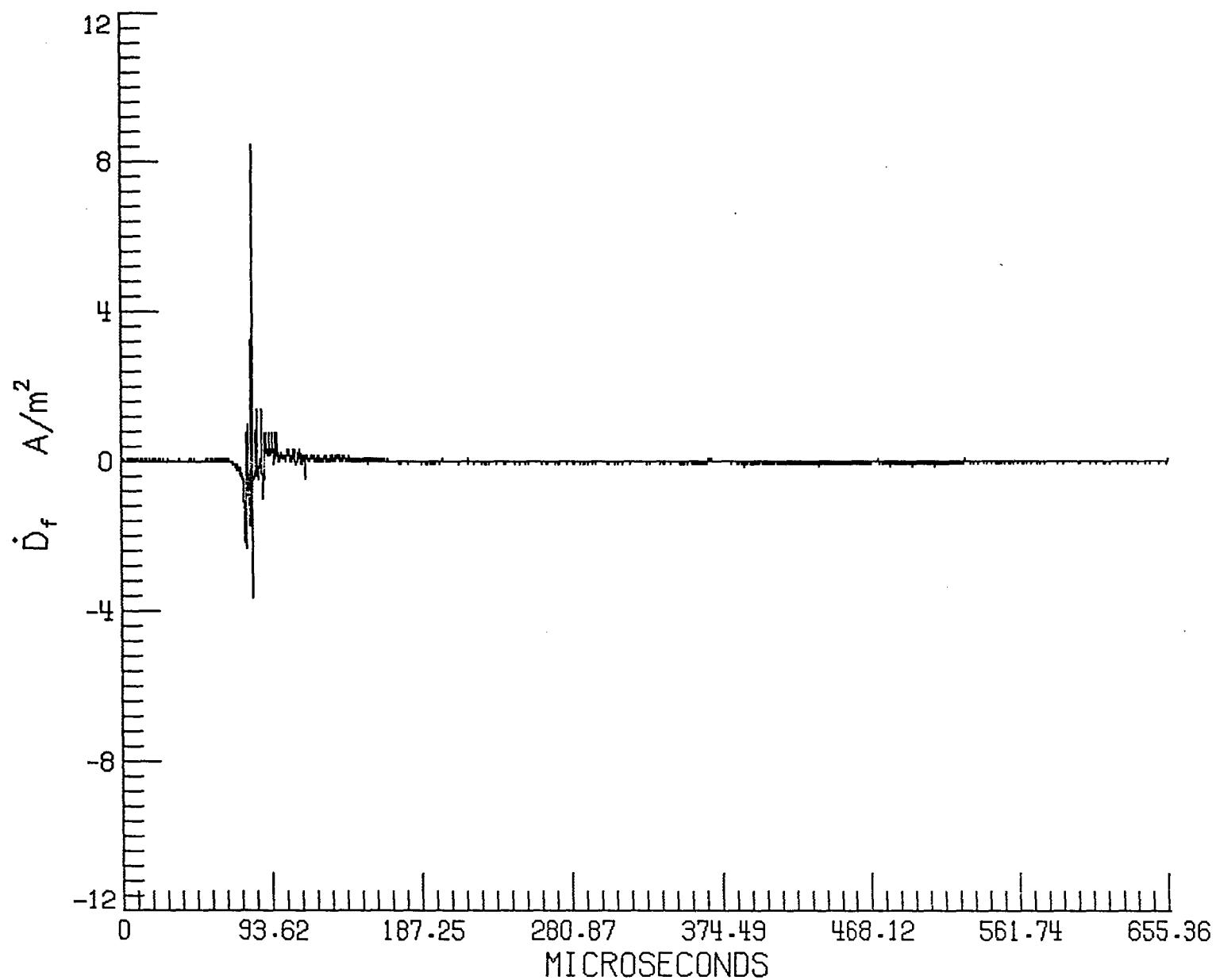




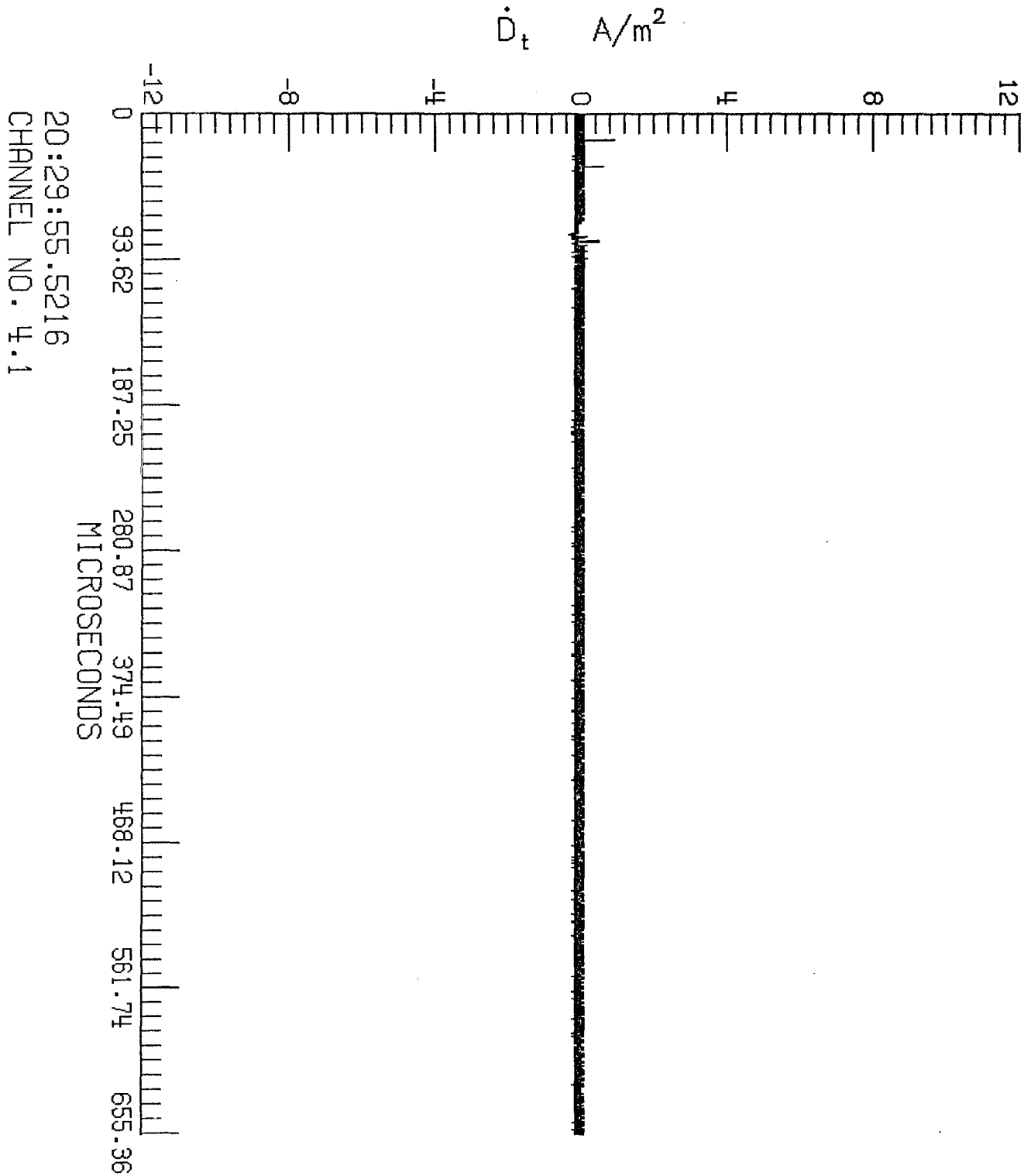
20:28:32.1819

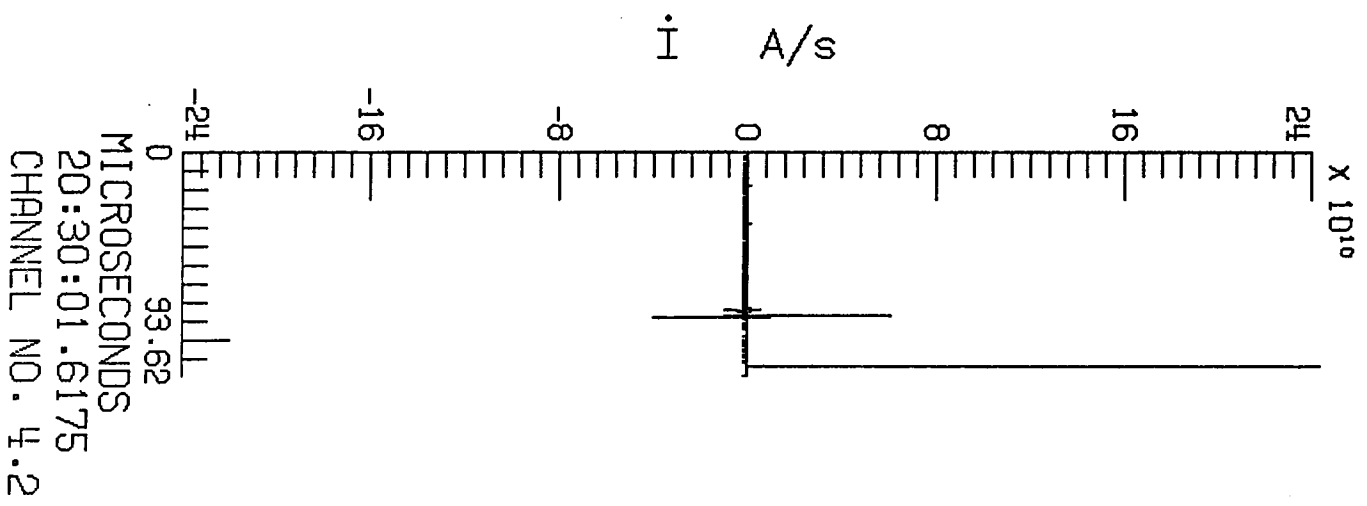
CHANNEL NO. 4.2

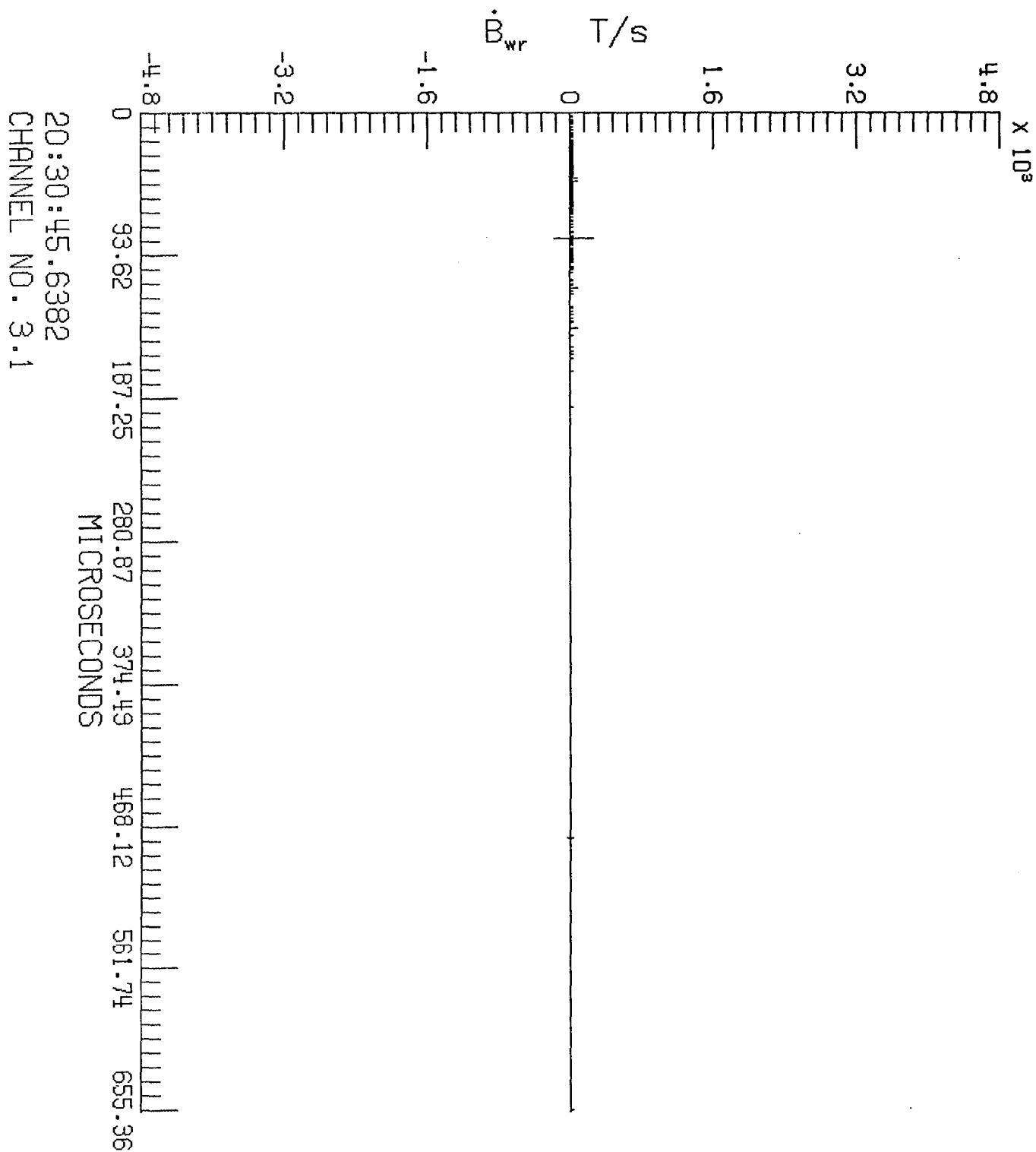


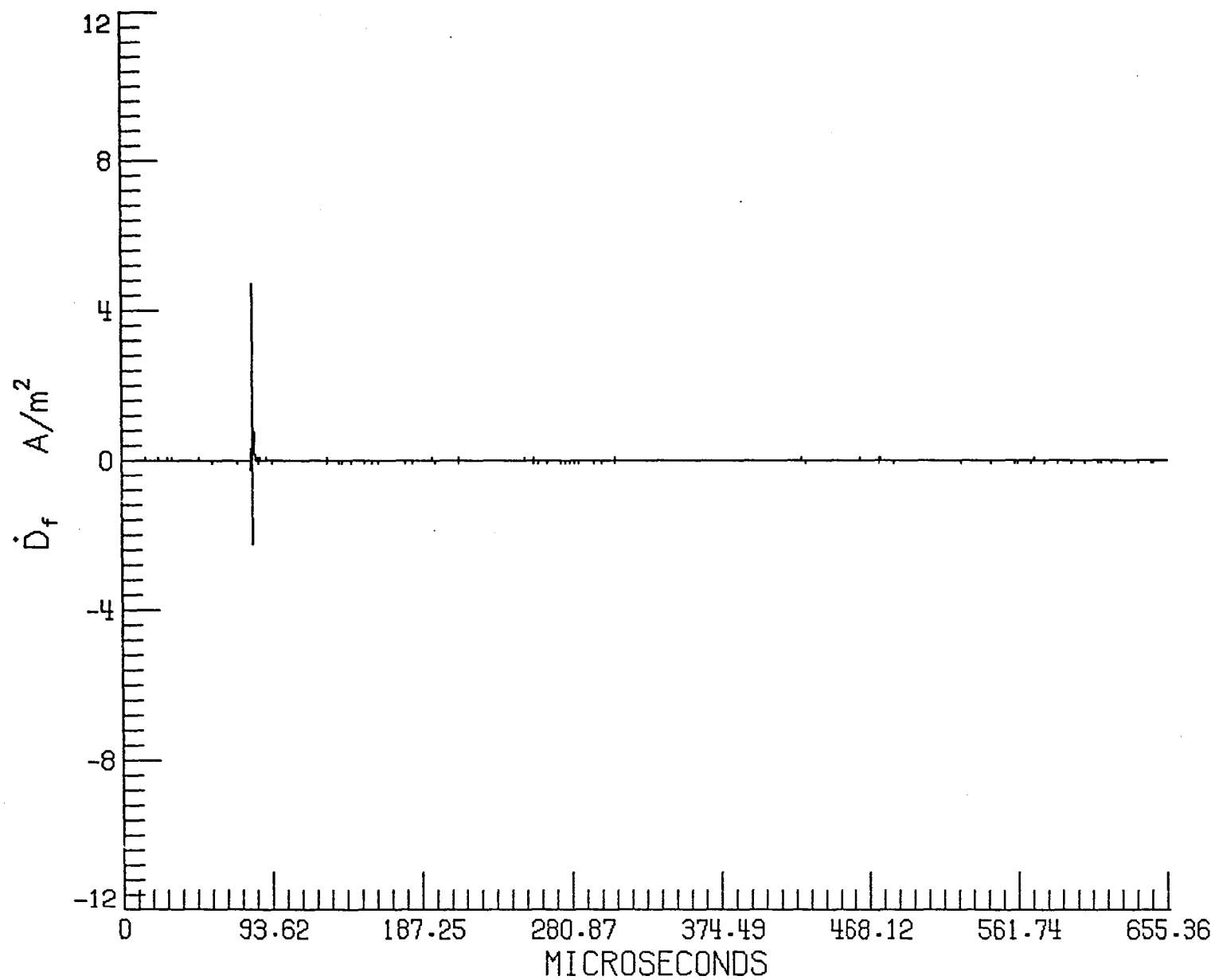


20:29:55.5528
CHANNEL NO. 3.2

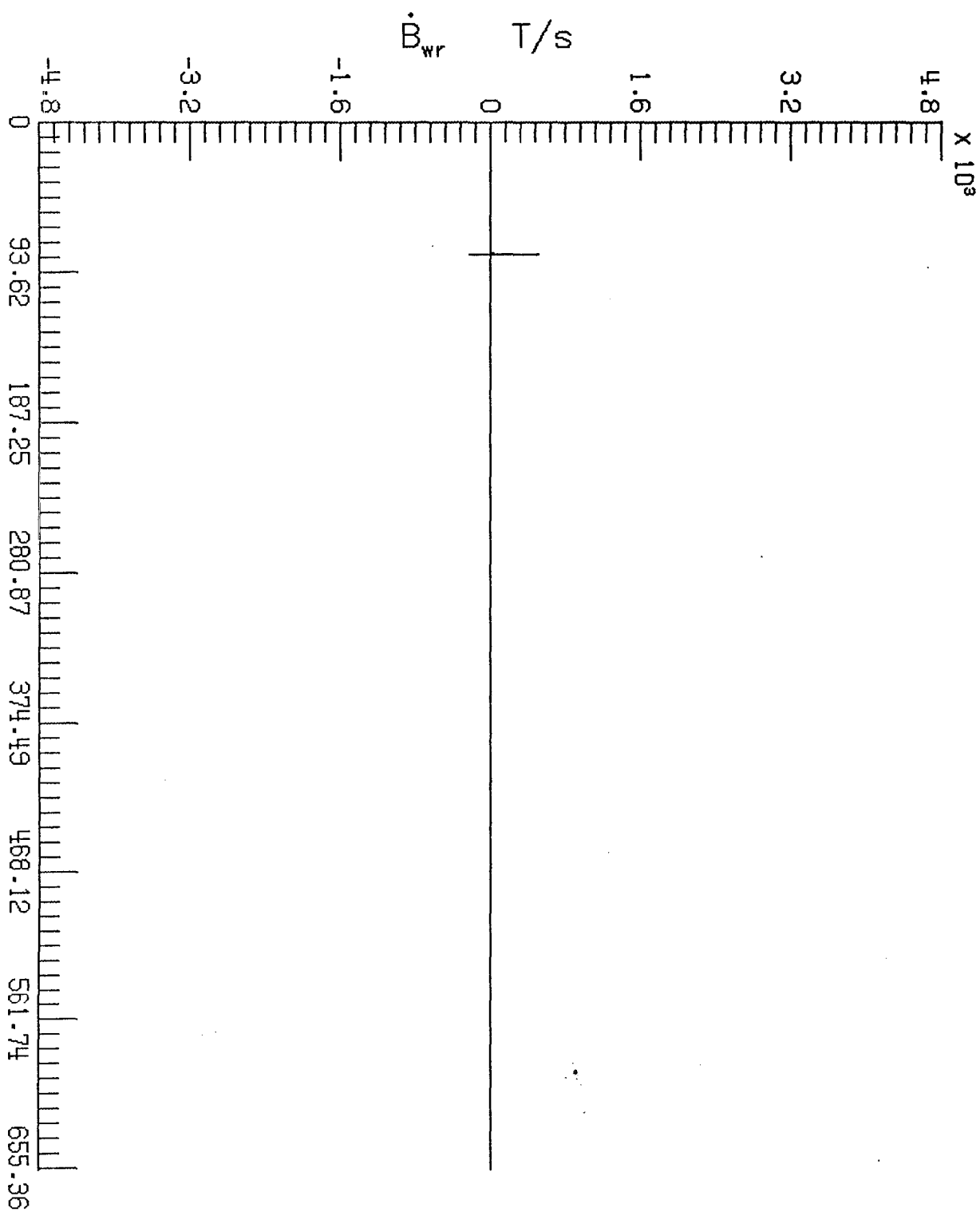




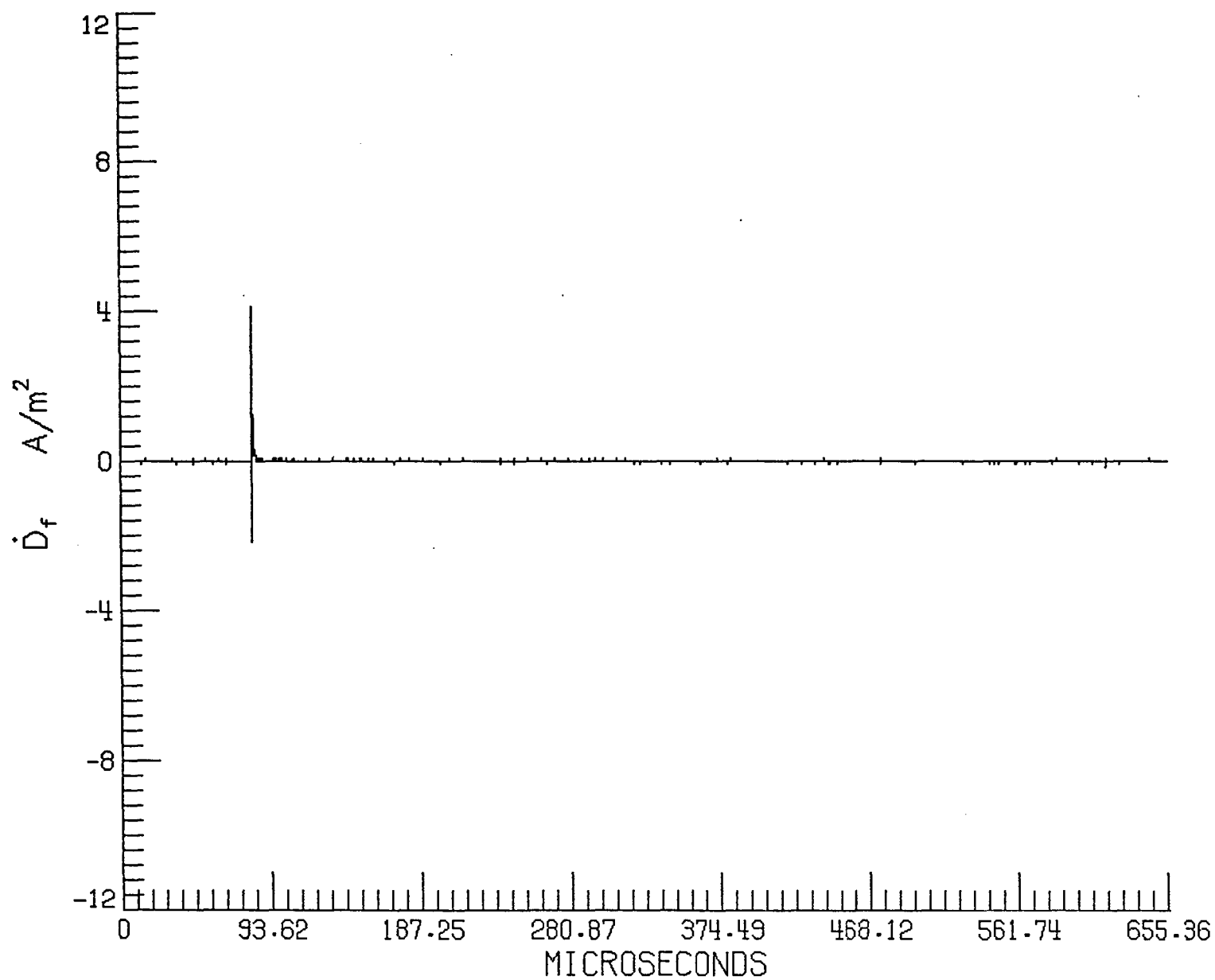




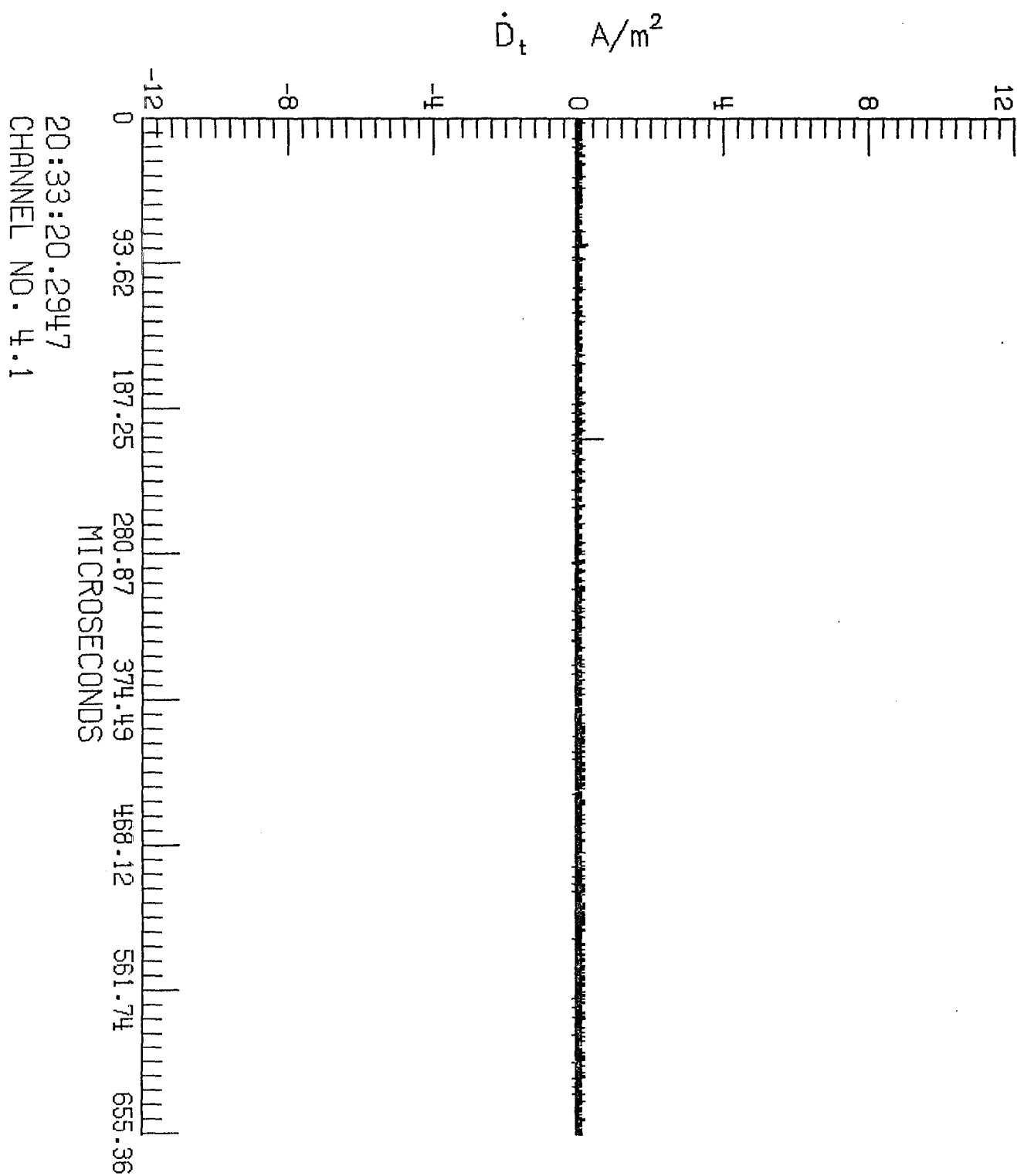
20:30:51.7343
CHANNEL NO. 3.2

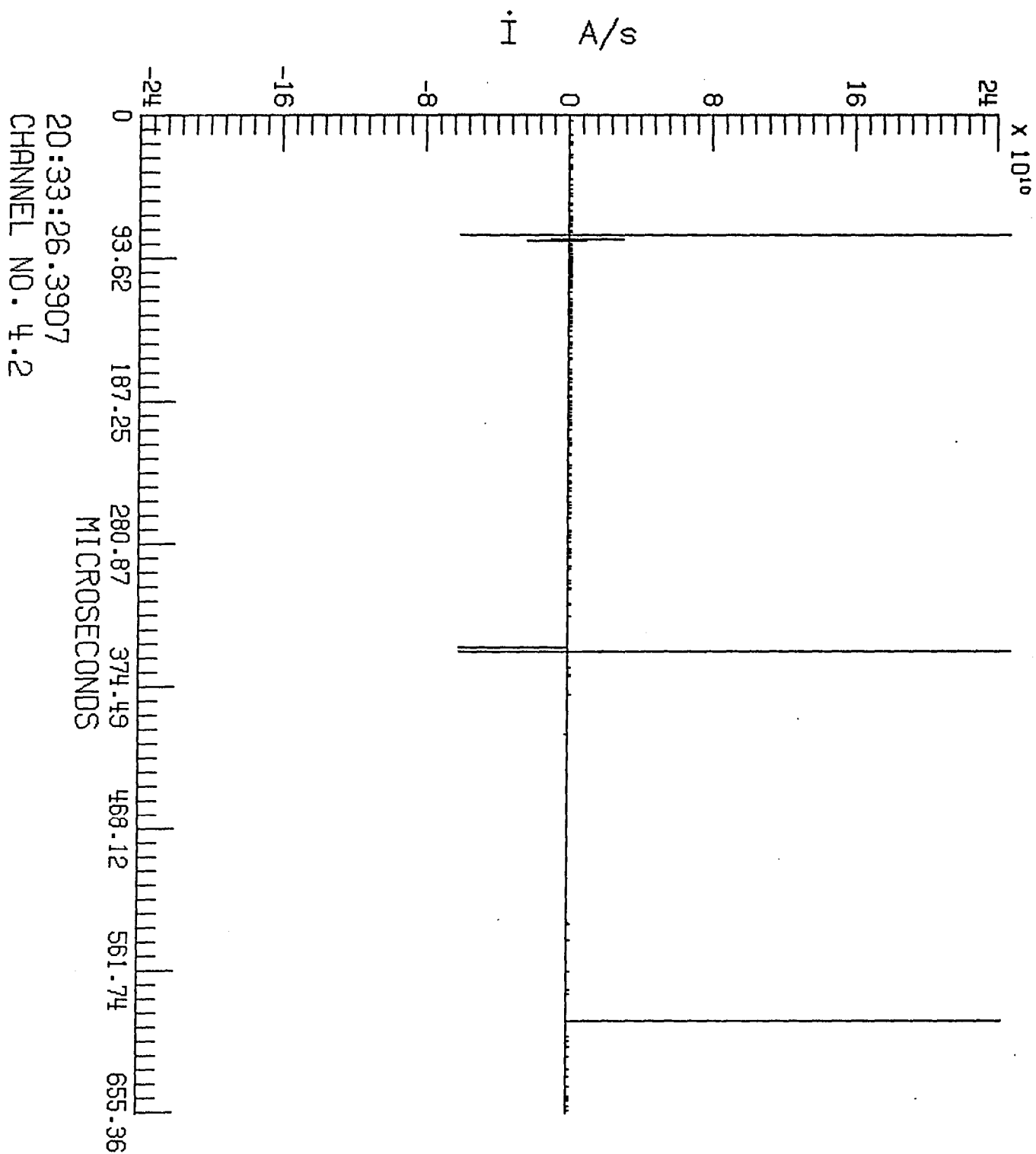


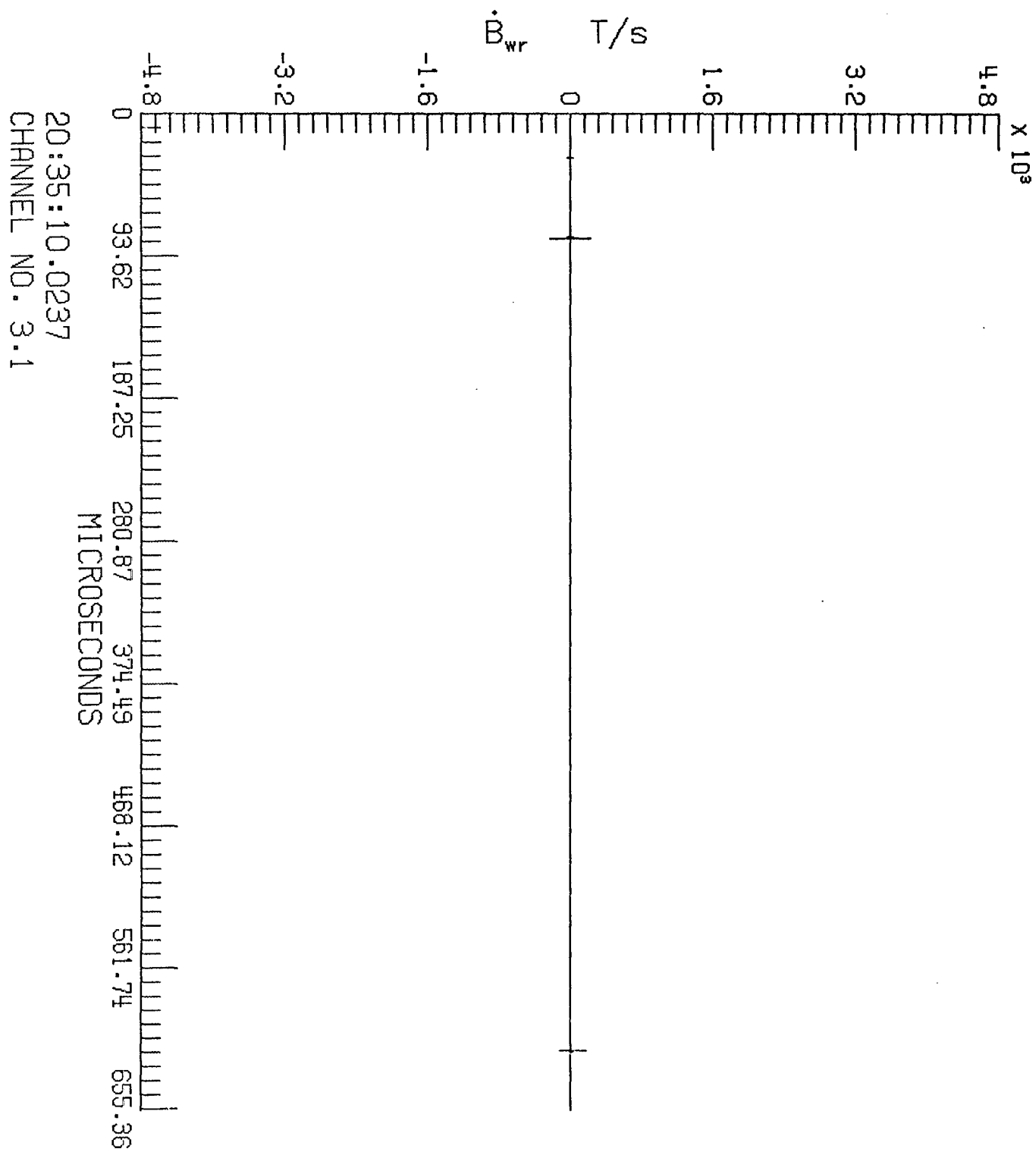
20:33:13.9370
CHANNEL NO. 3.1

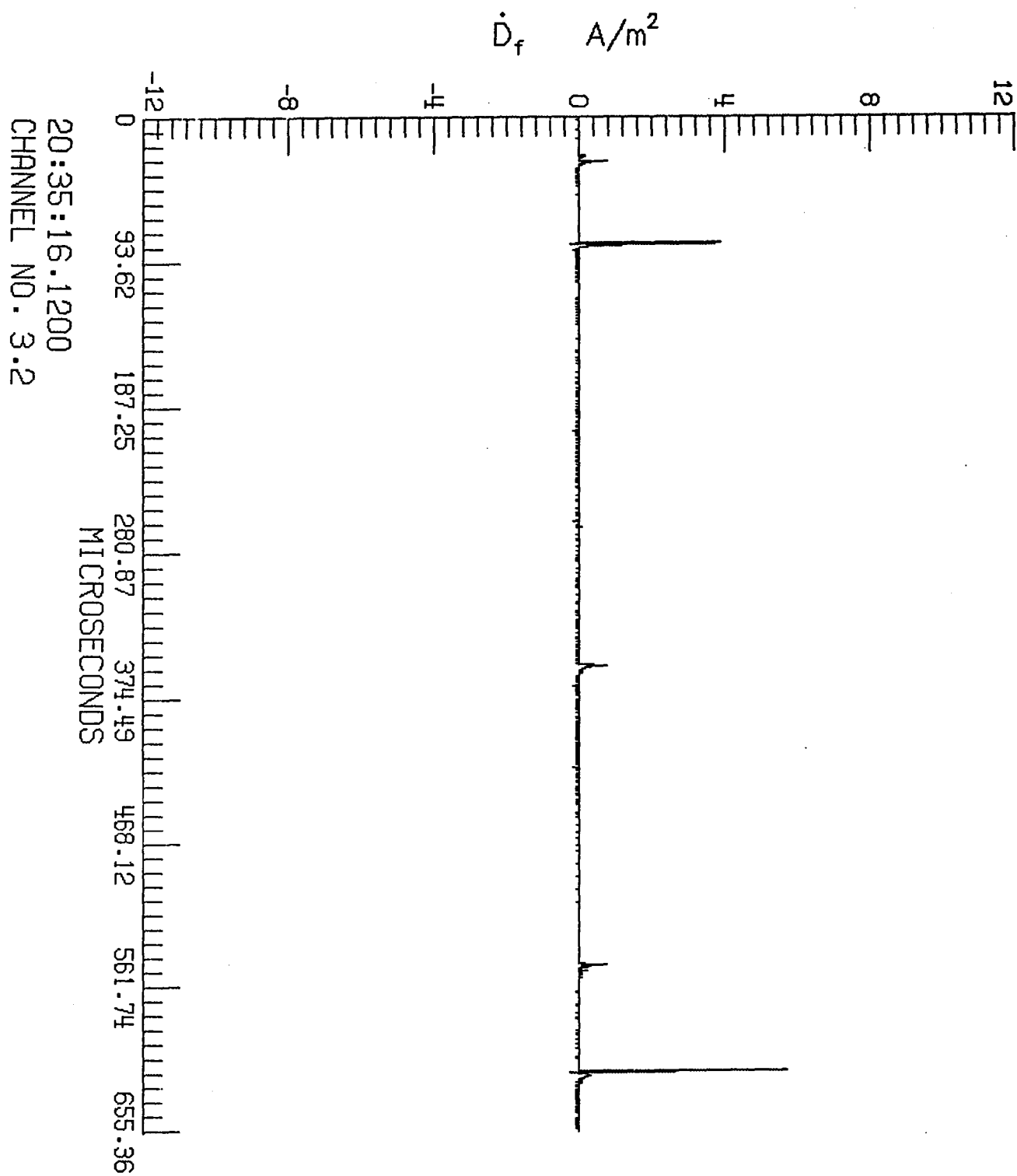


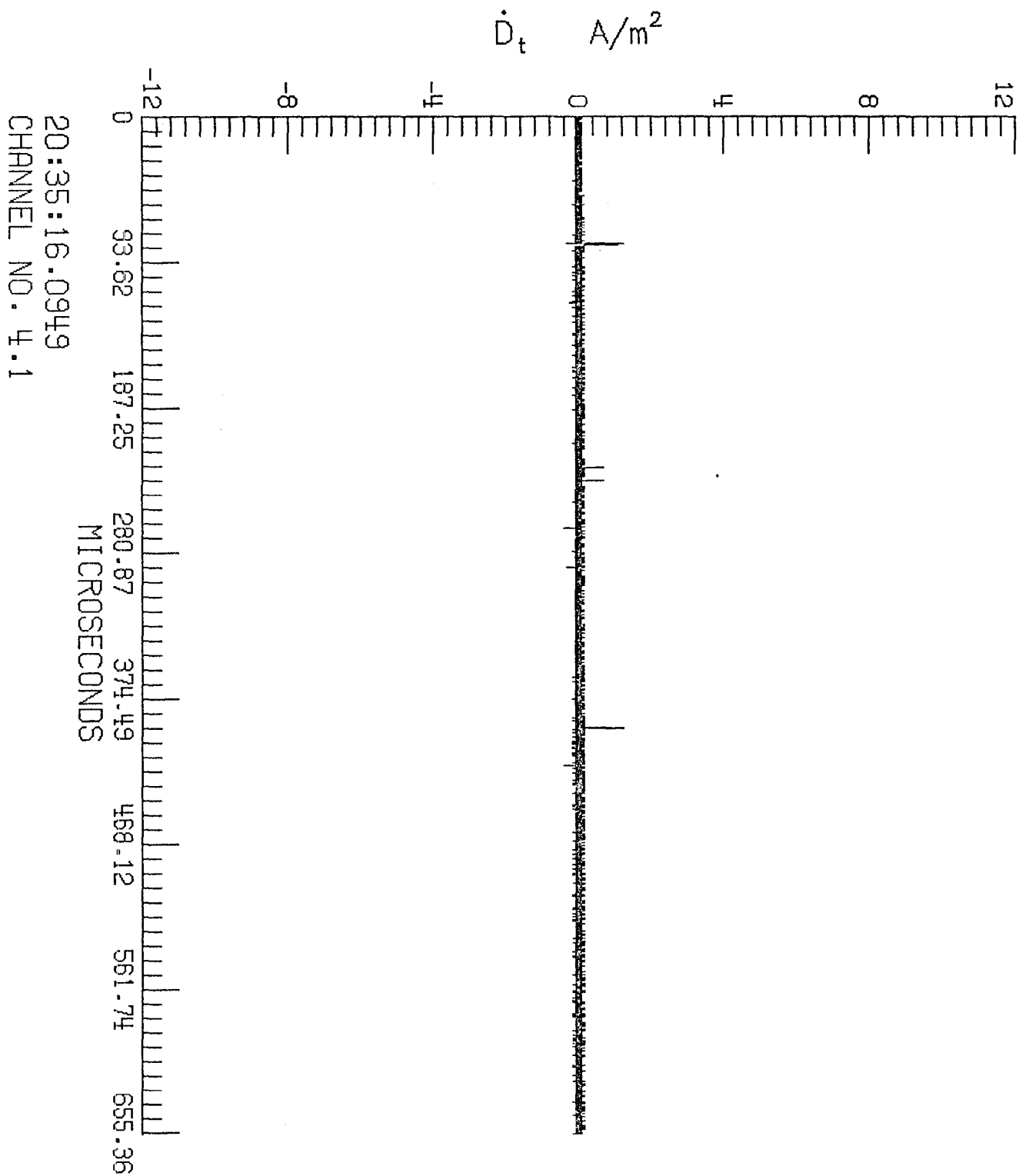
20:33:20.0330
CHANNEL NO. 3.2

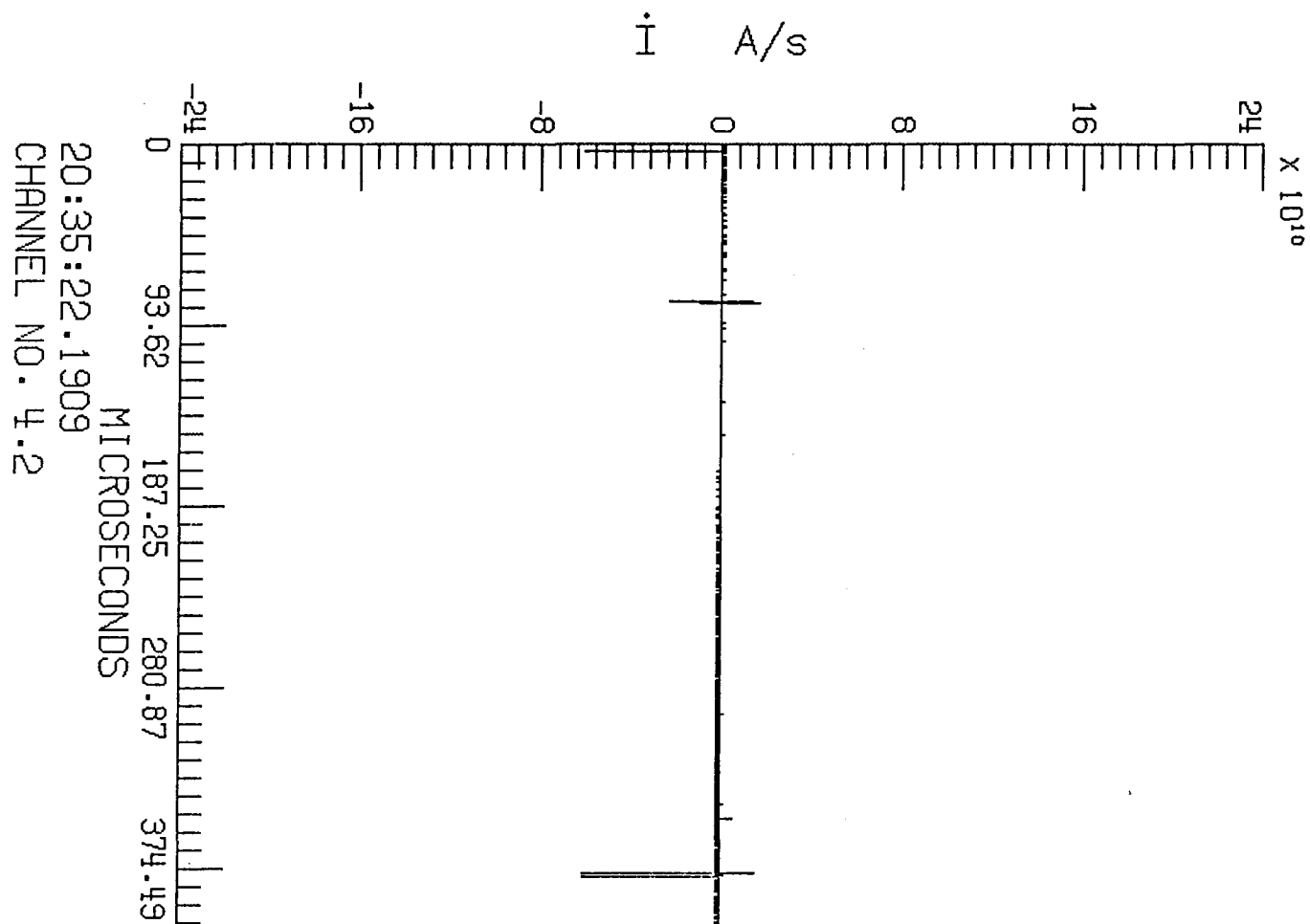


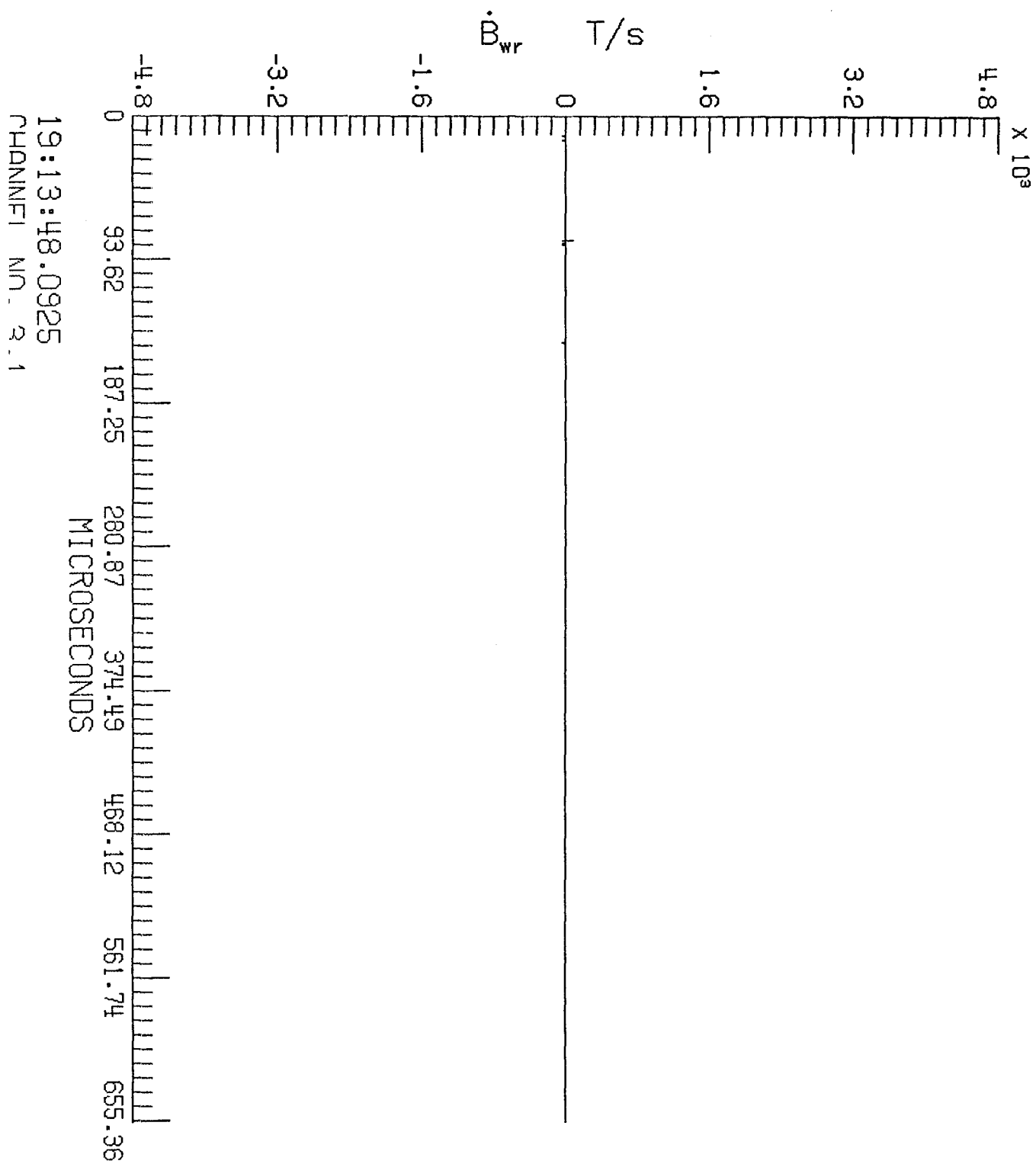


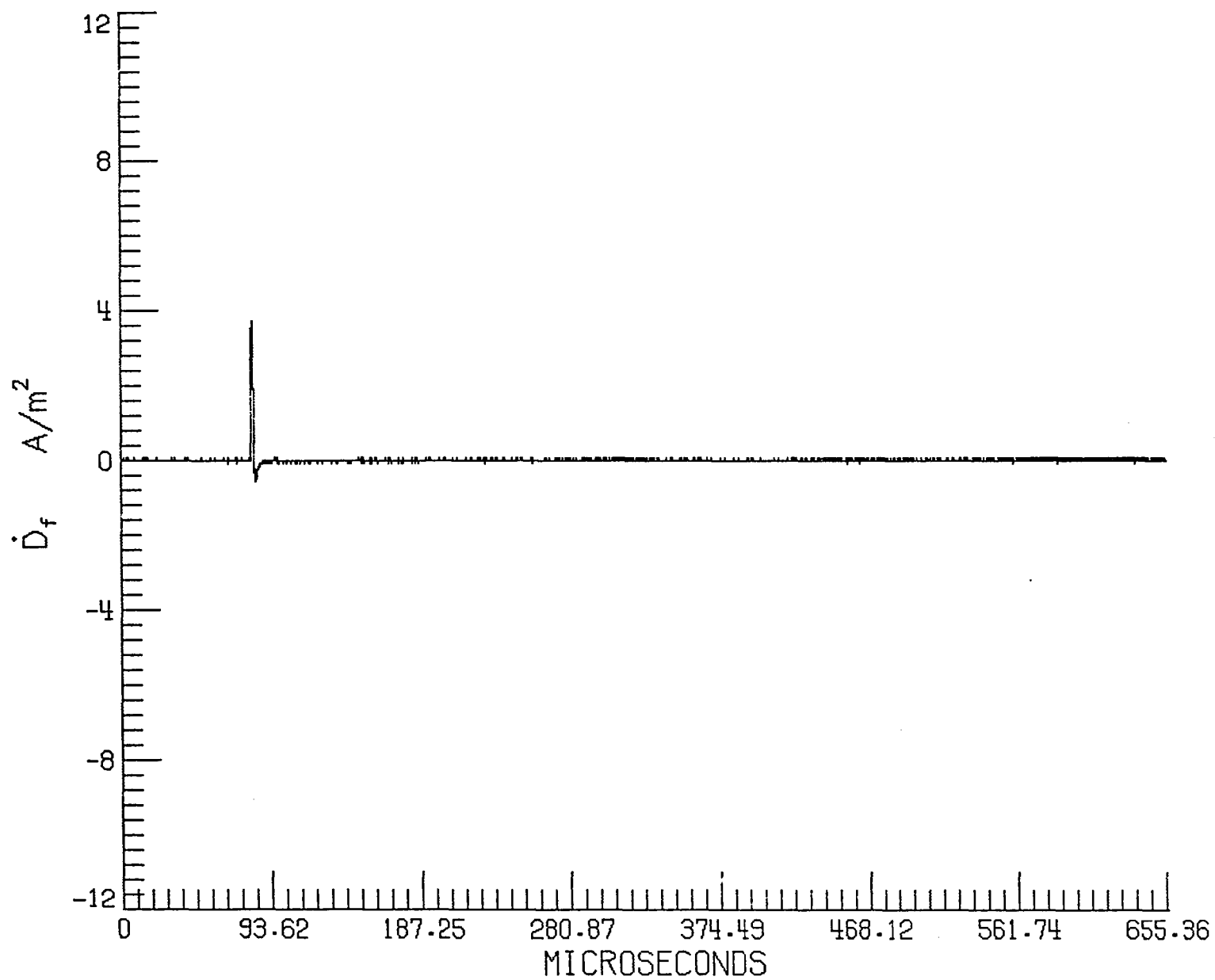




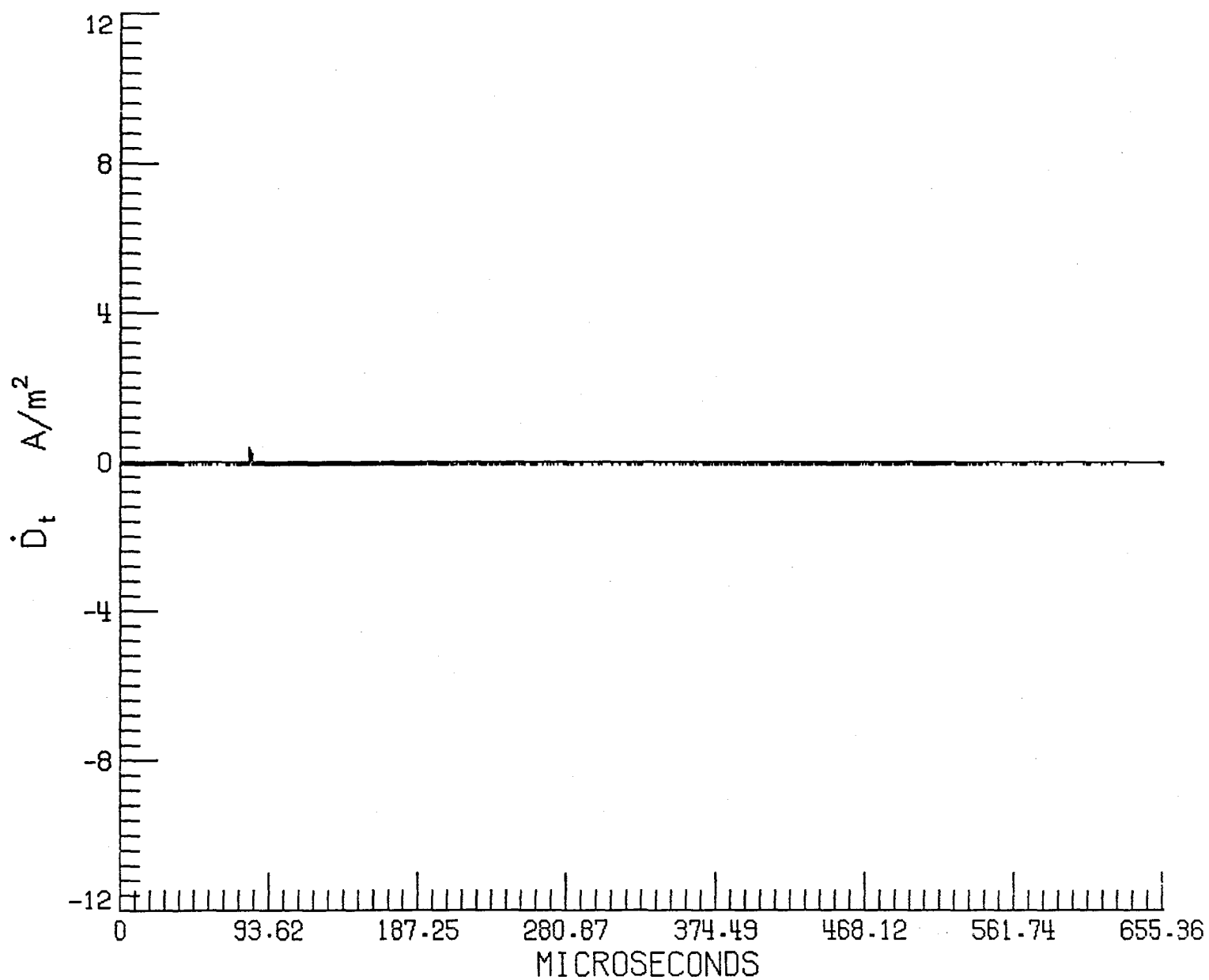




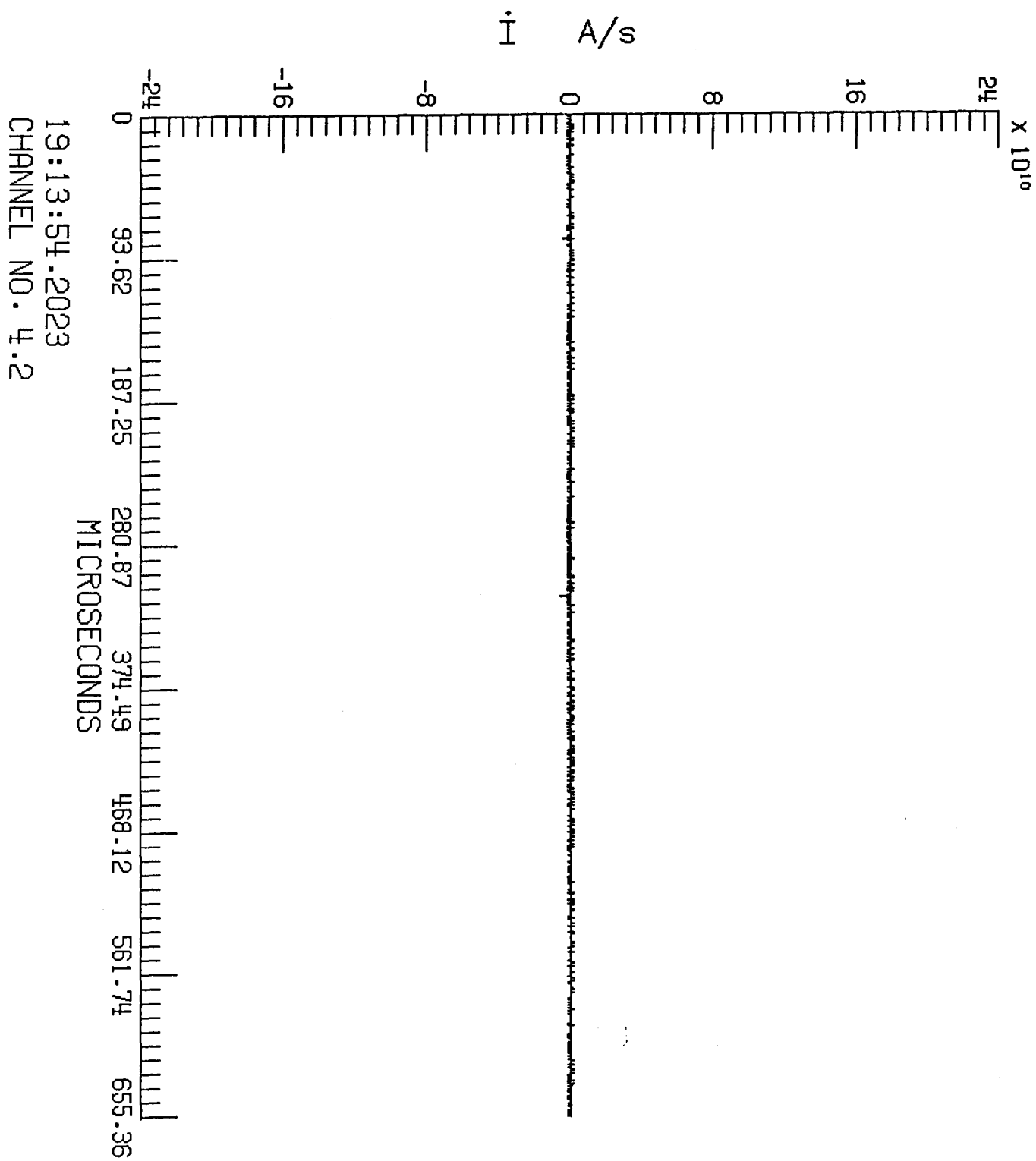


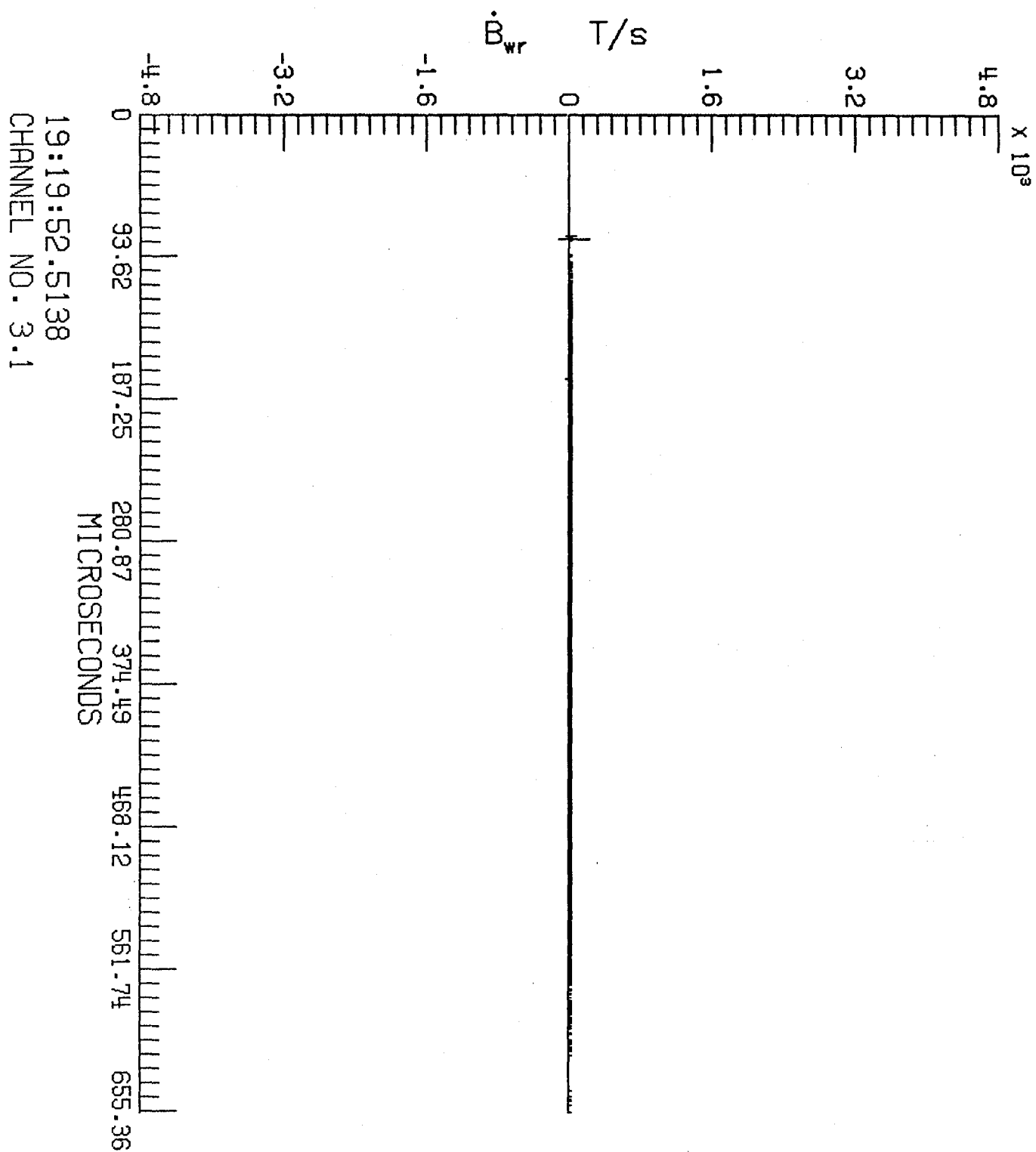


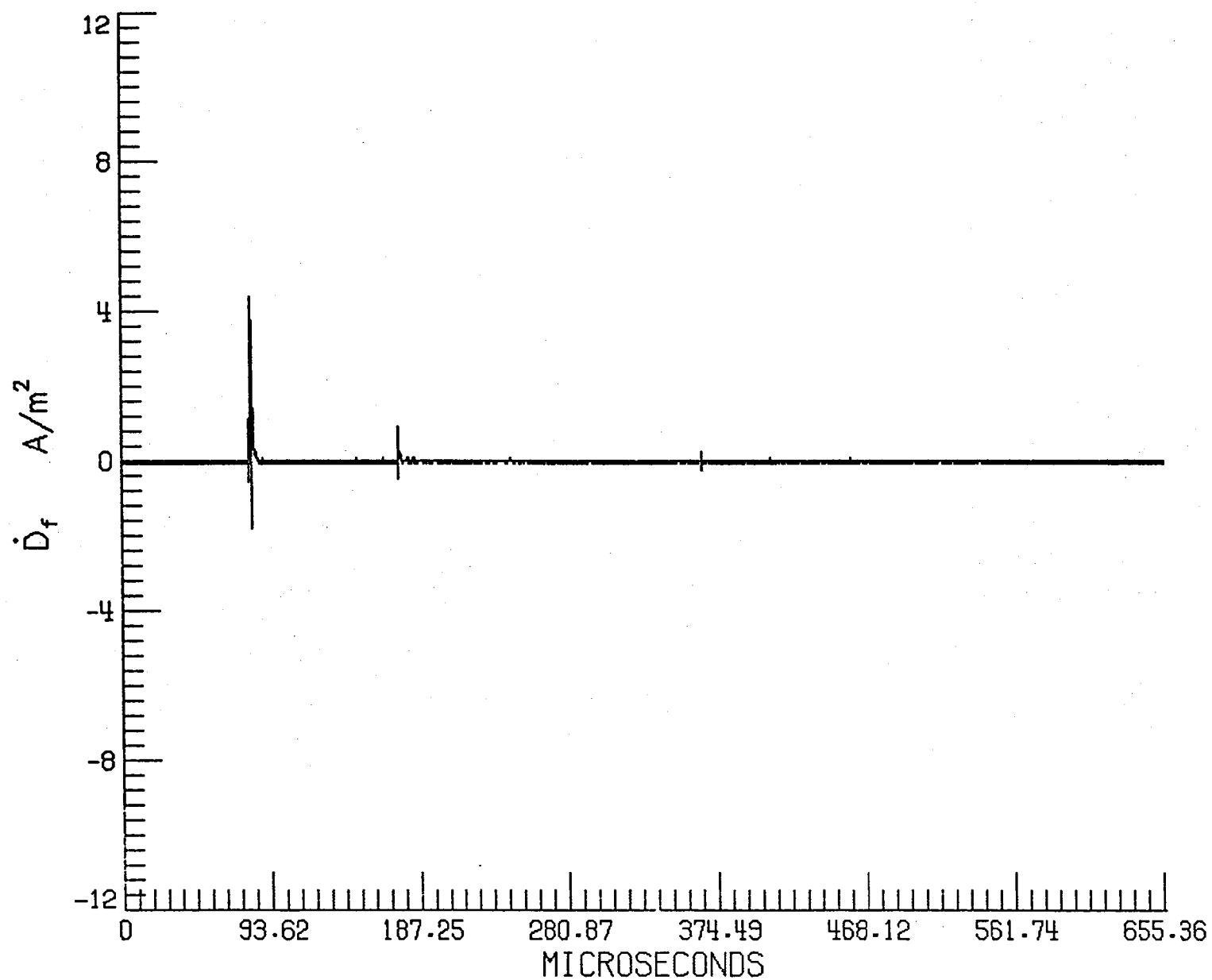
19:13:54.1885
CHANNEL NO. 3.2



19:13:48.1063
CHANNEL NO. 4.1

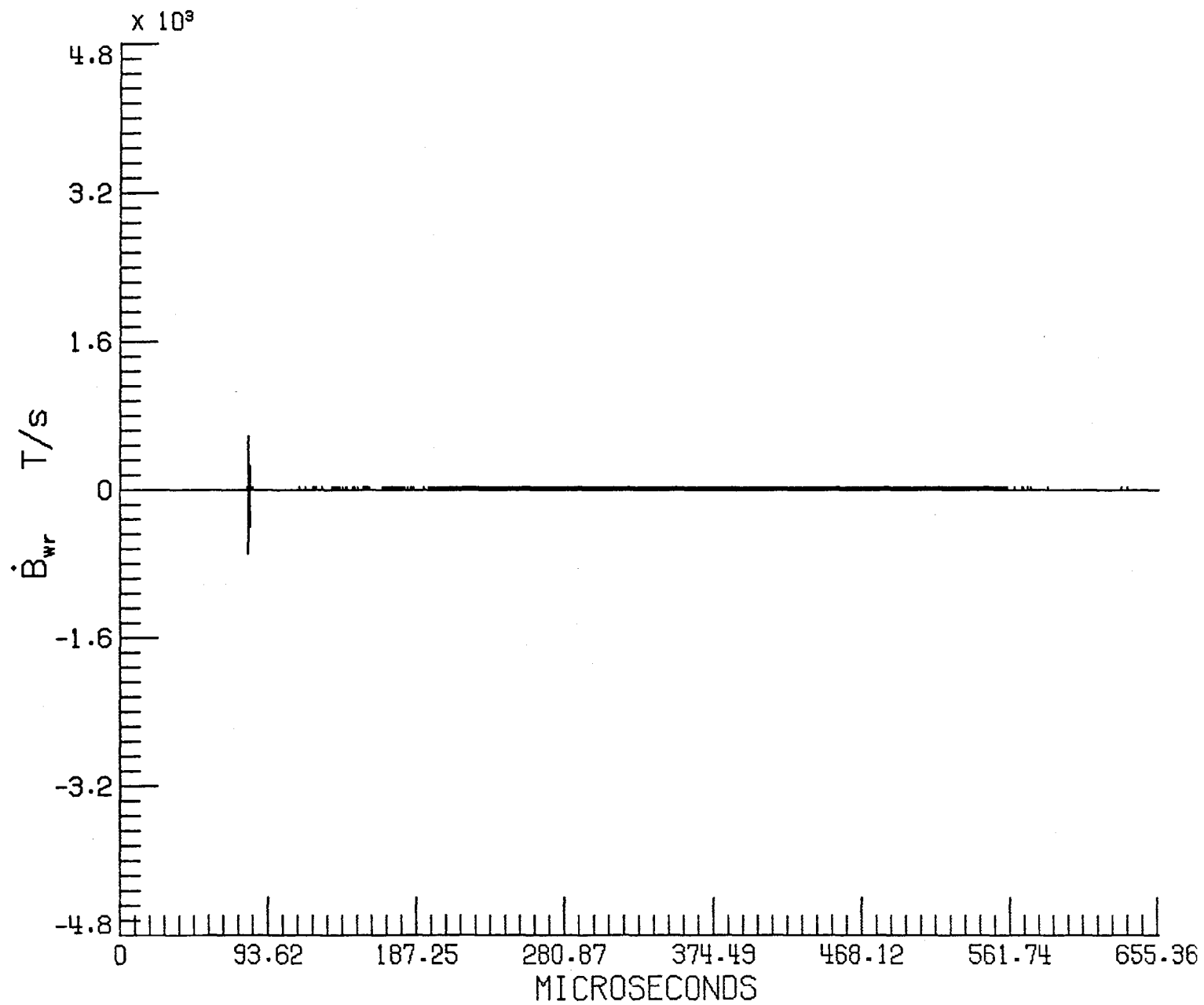






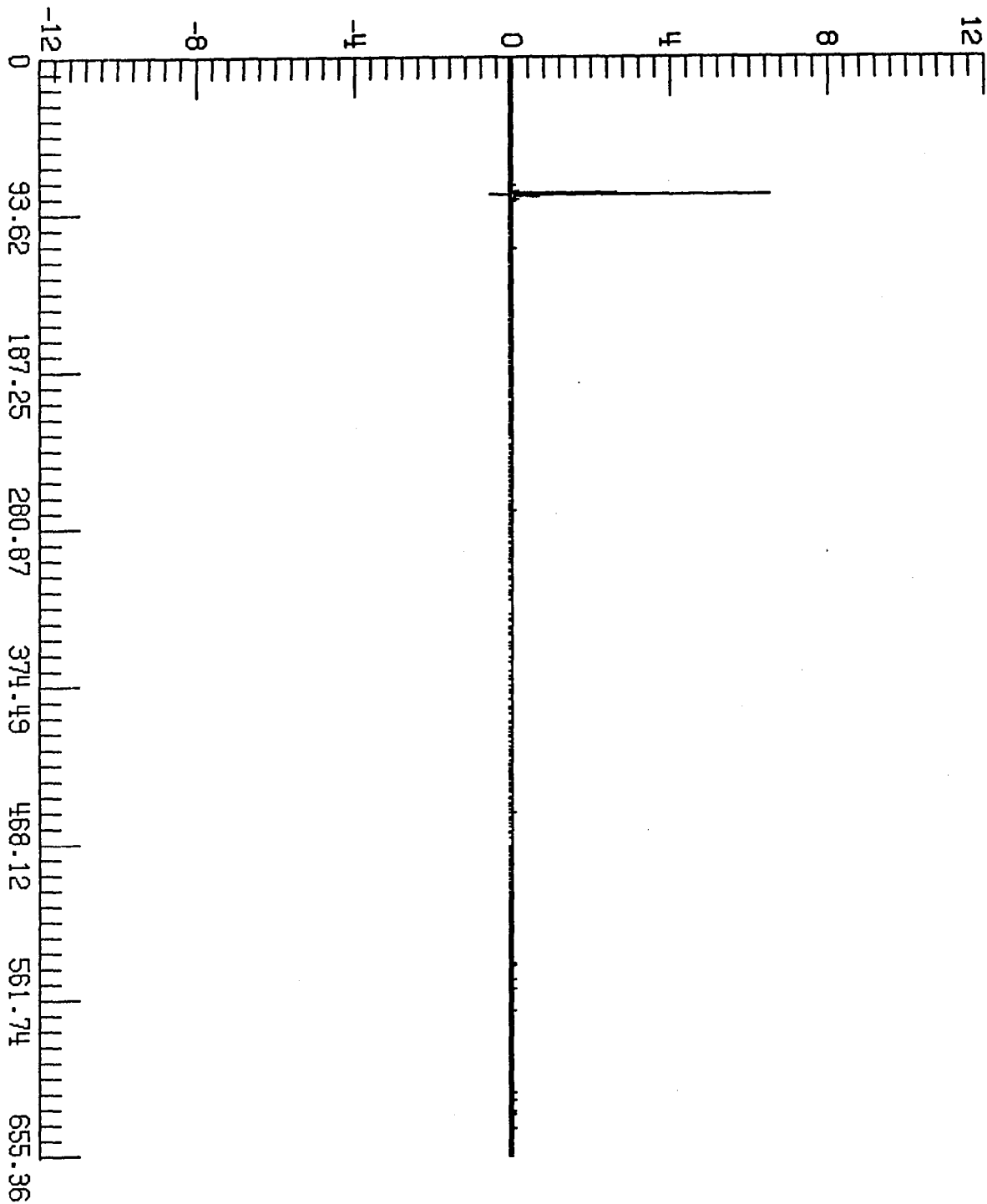
19:19:58.6098

CHANNEL NO. 3.2



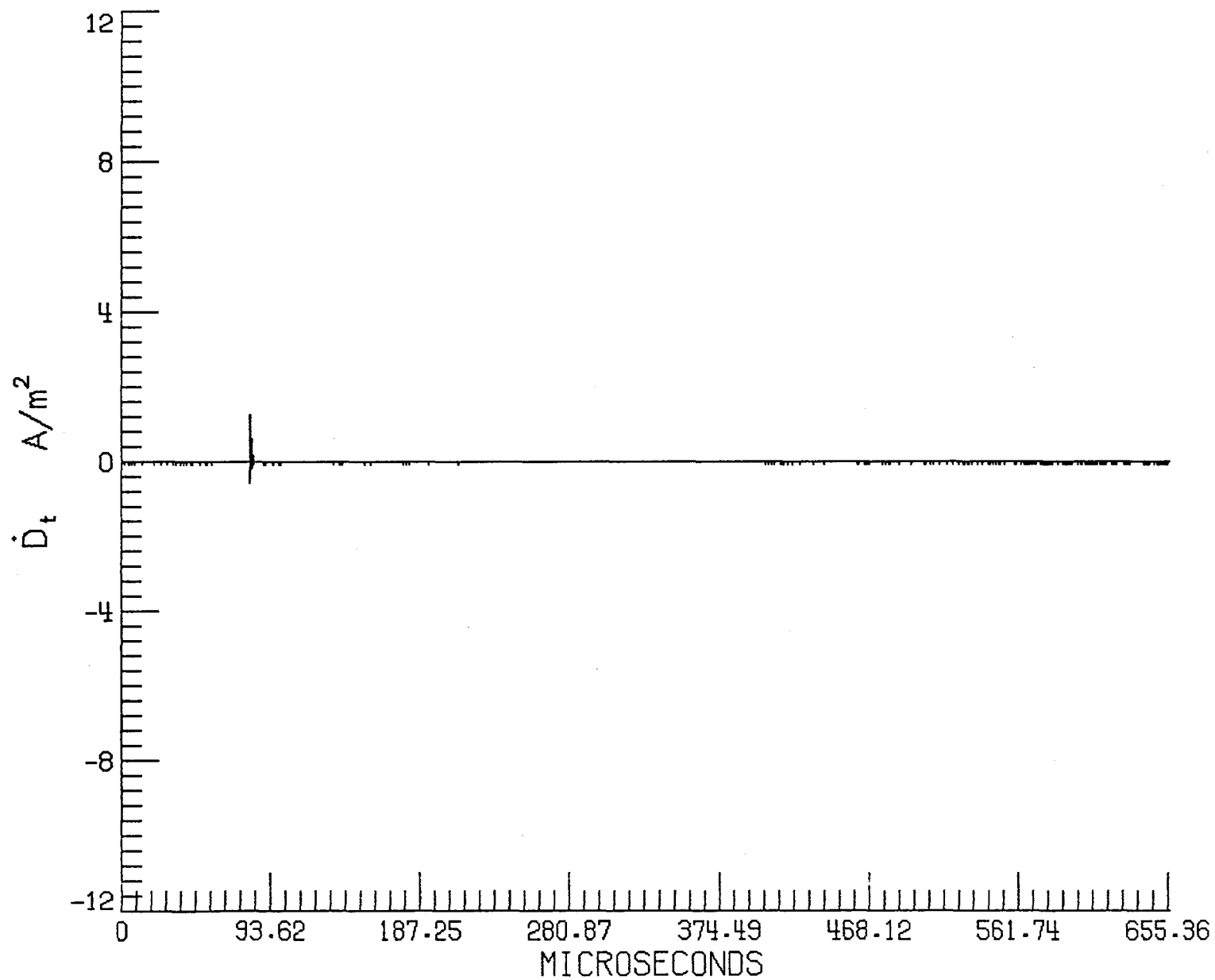
19:22:35.1024
CHANNEL NO. 3.1

\dot{D}_f A/m^2

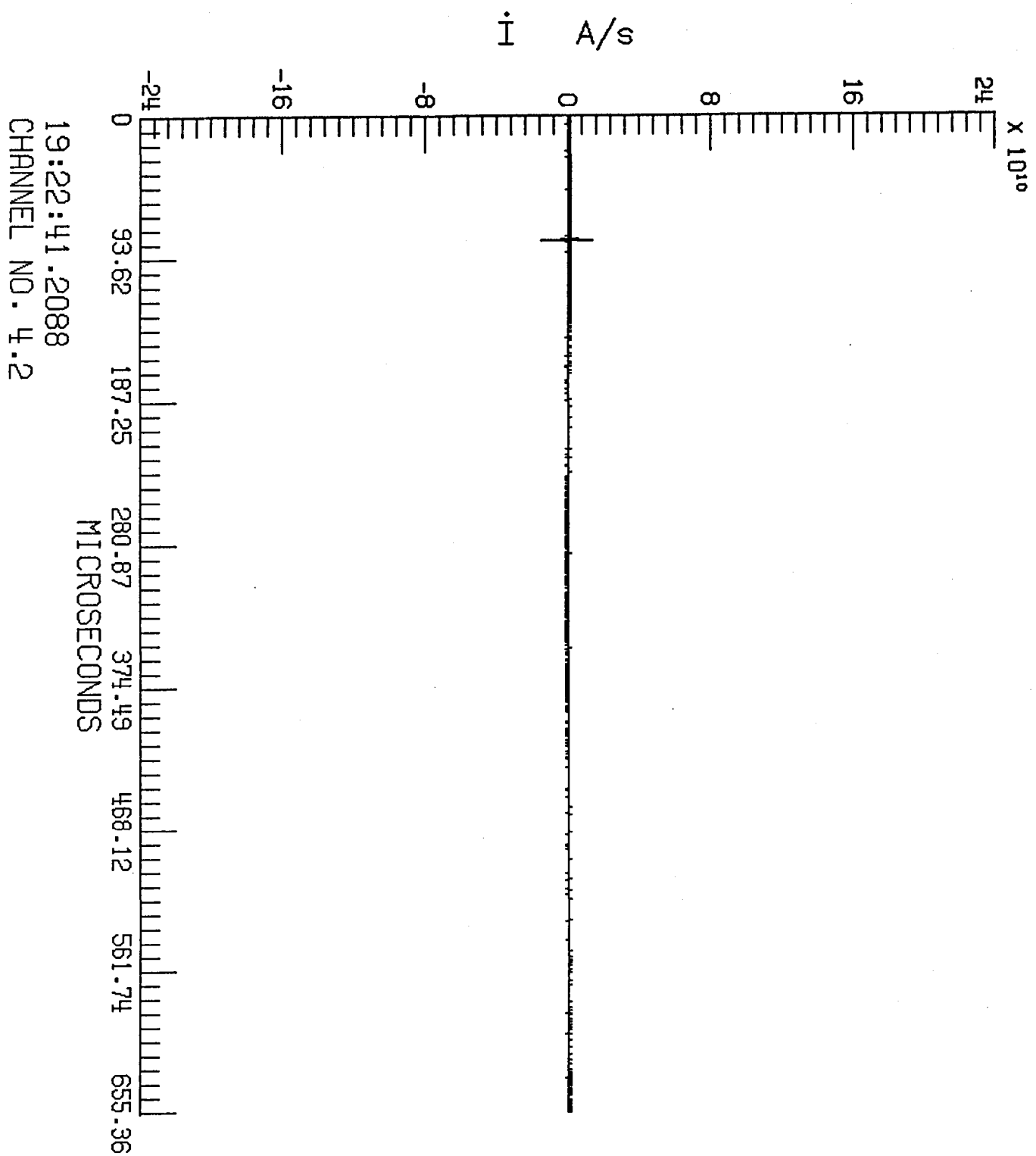


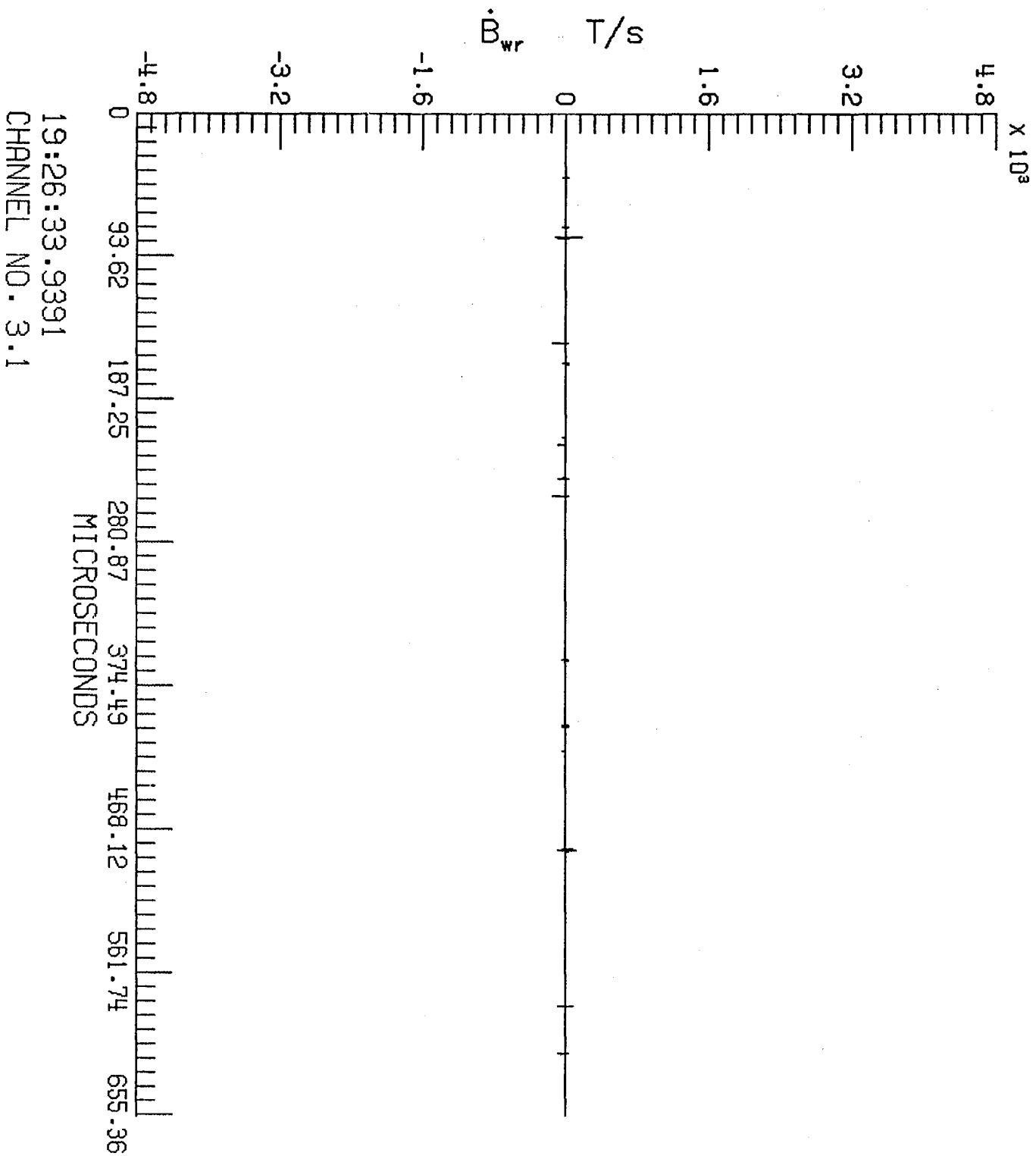
19:22:41.1984
CHANNEL NO. 3.2

MICROSECONDS

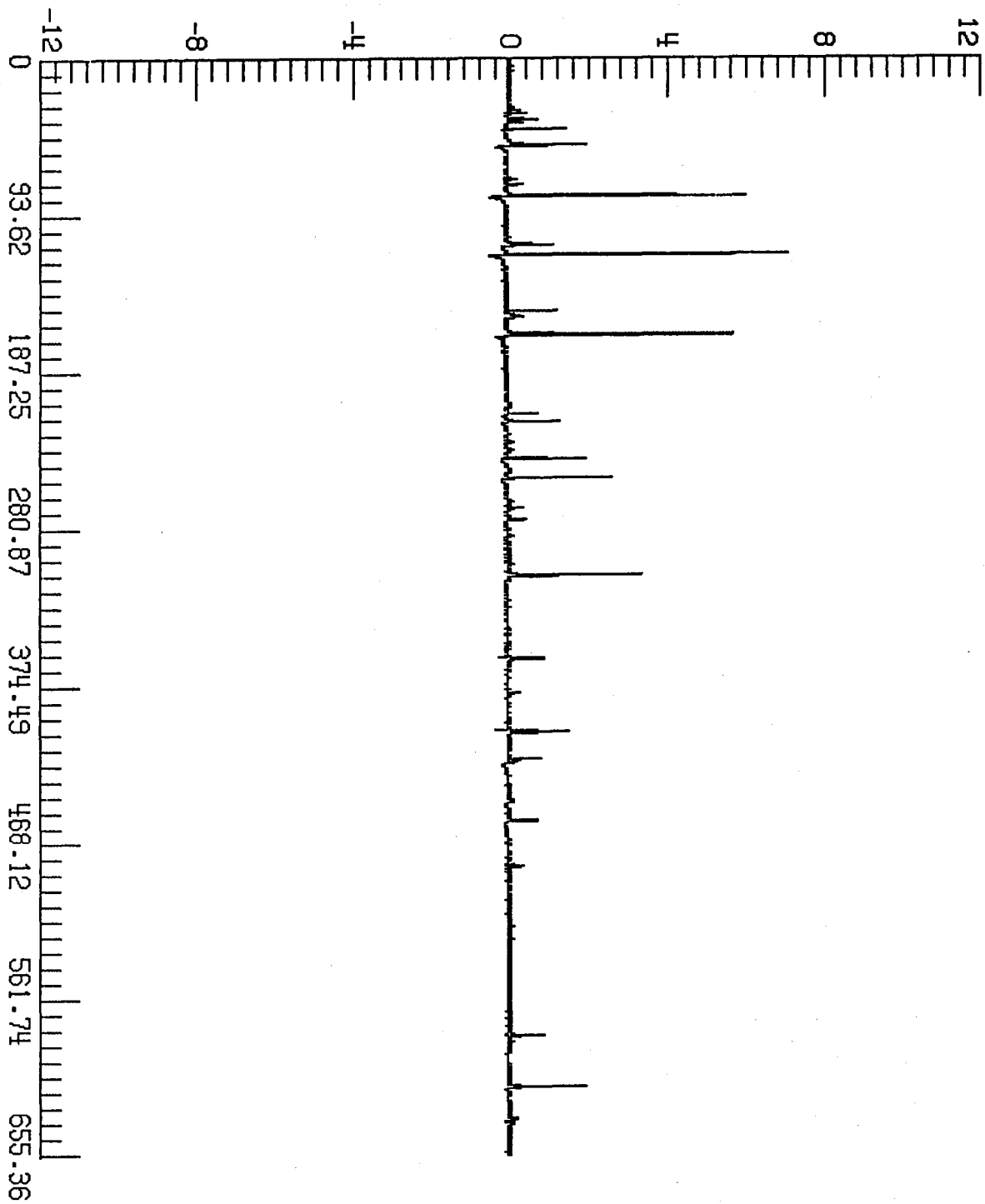


19:22:35.1128
CHANNEL NO. 4.1

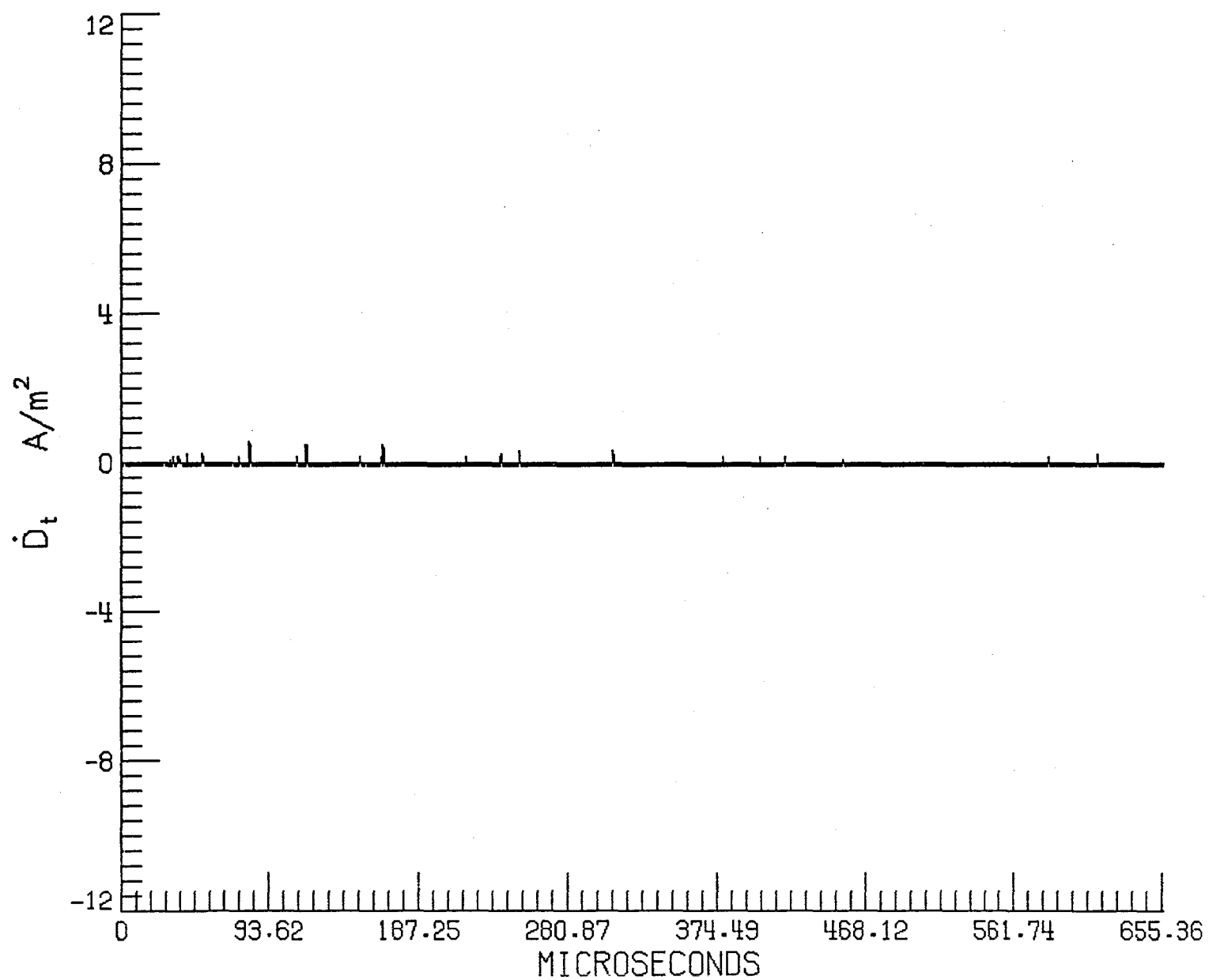




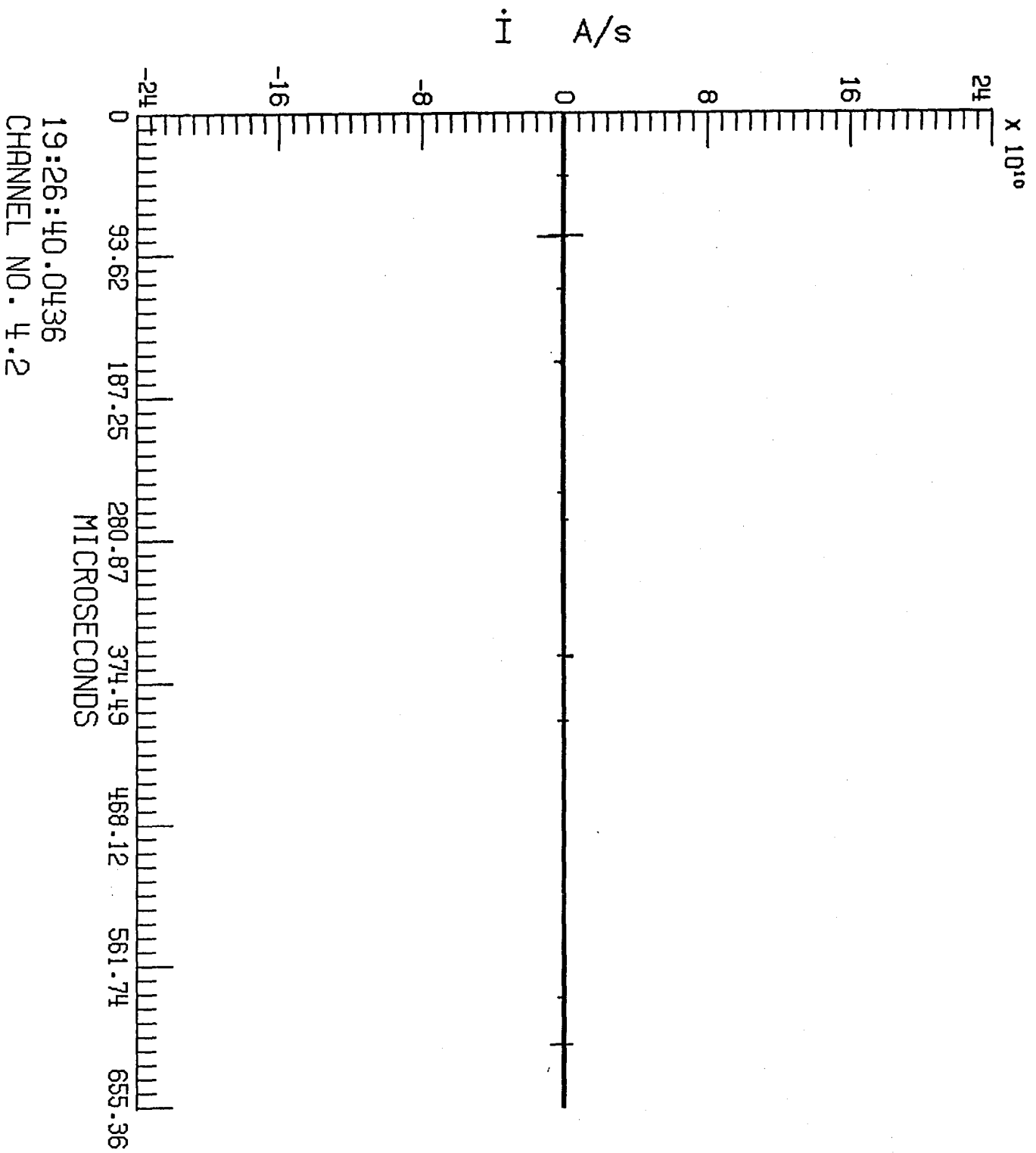
\dot{D}_f A/m²

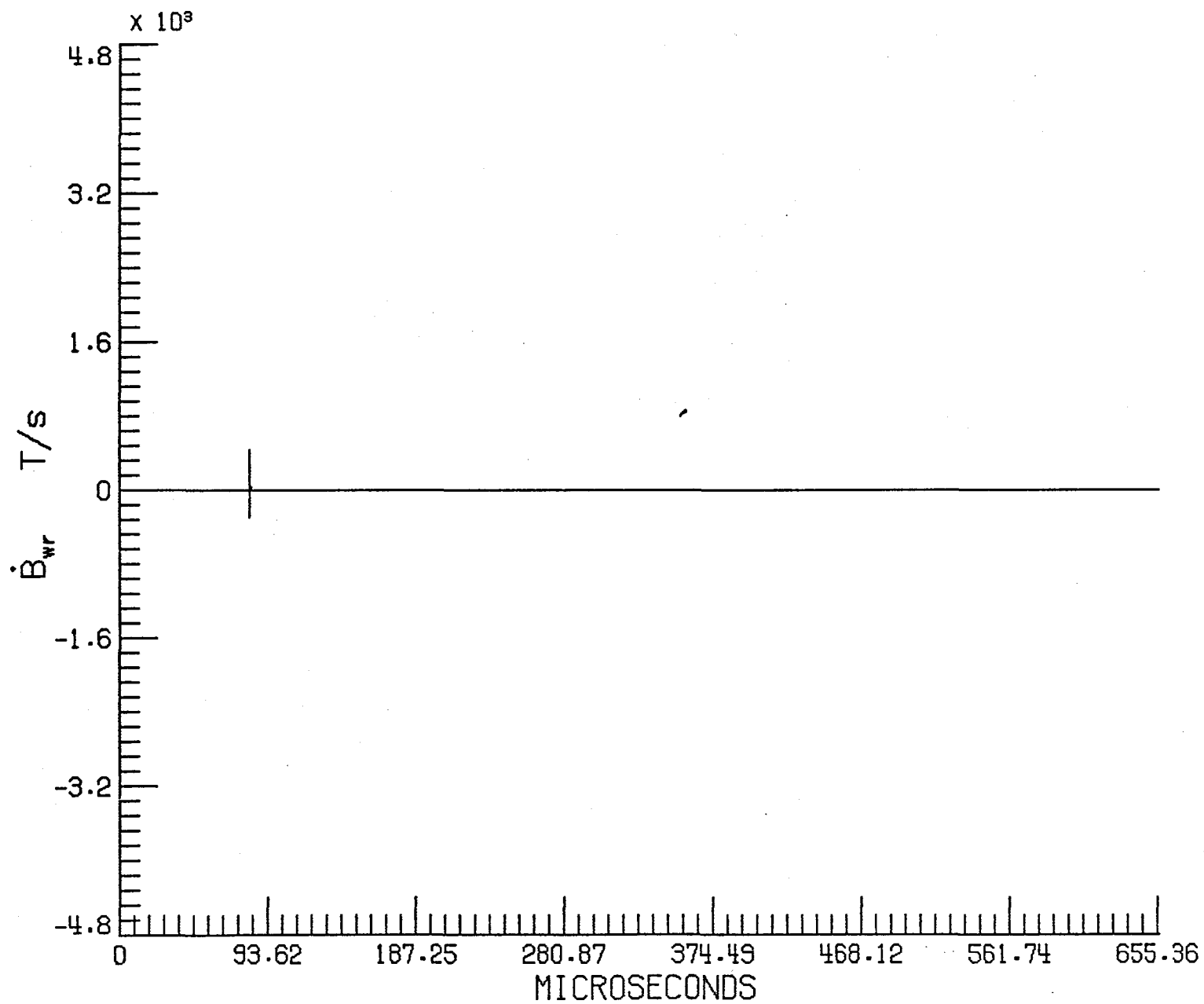


19:26:40.0351
CHANNEL NO. 3.2

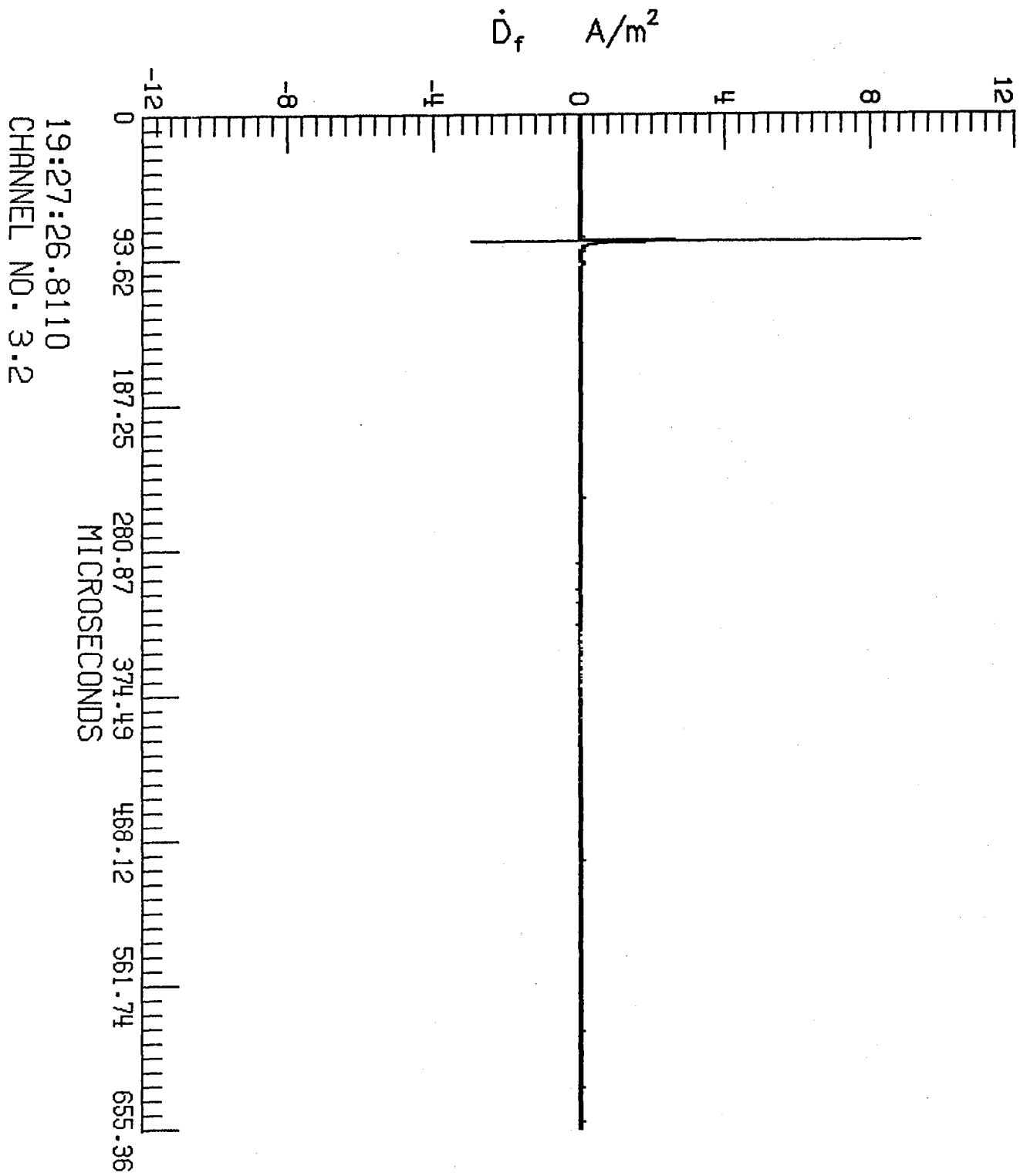


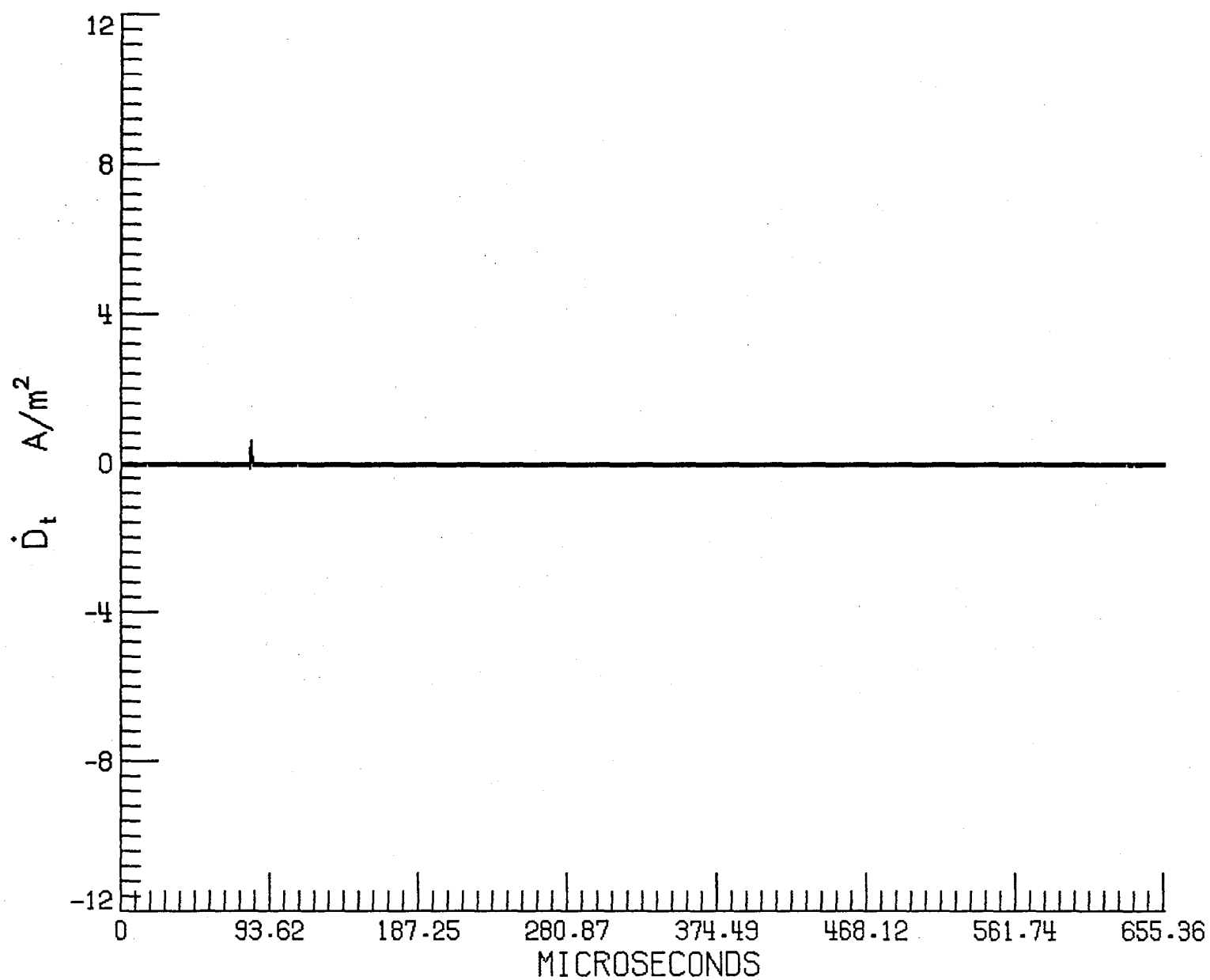
19:26:33.9476
CHANNEL NO. 4.1



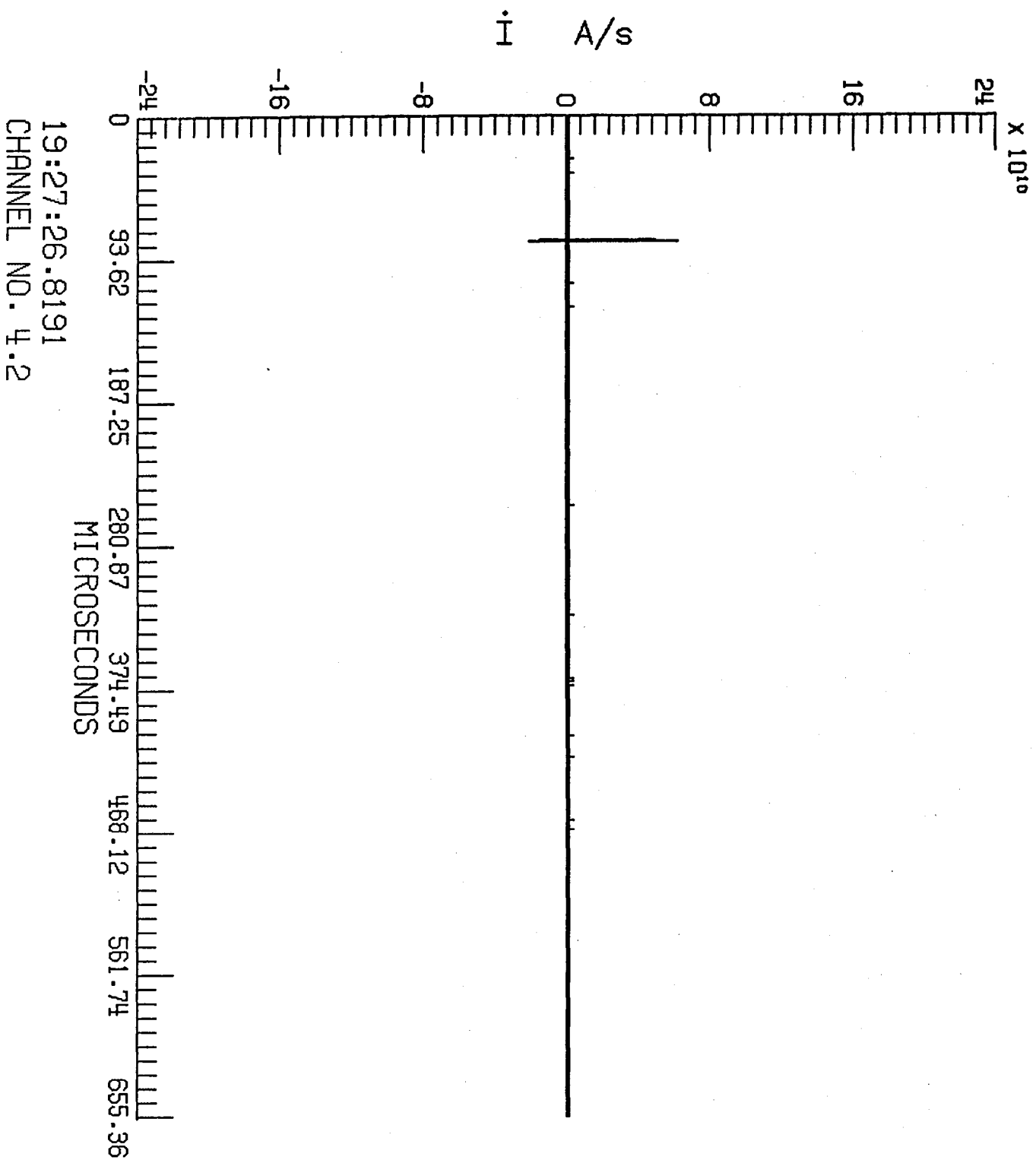


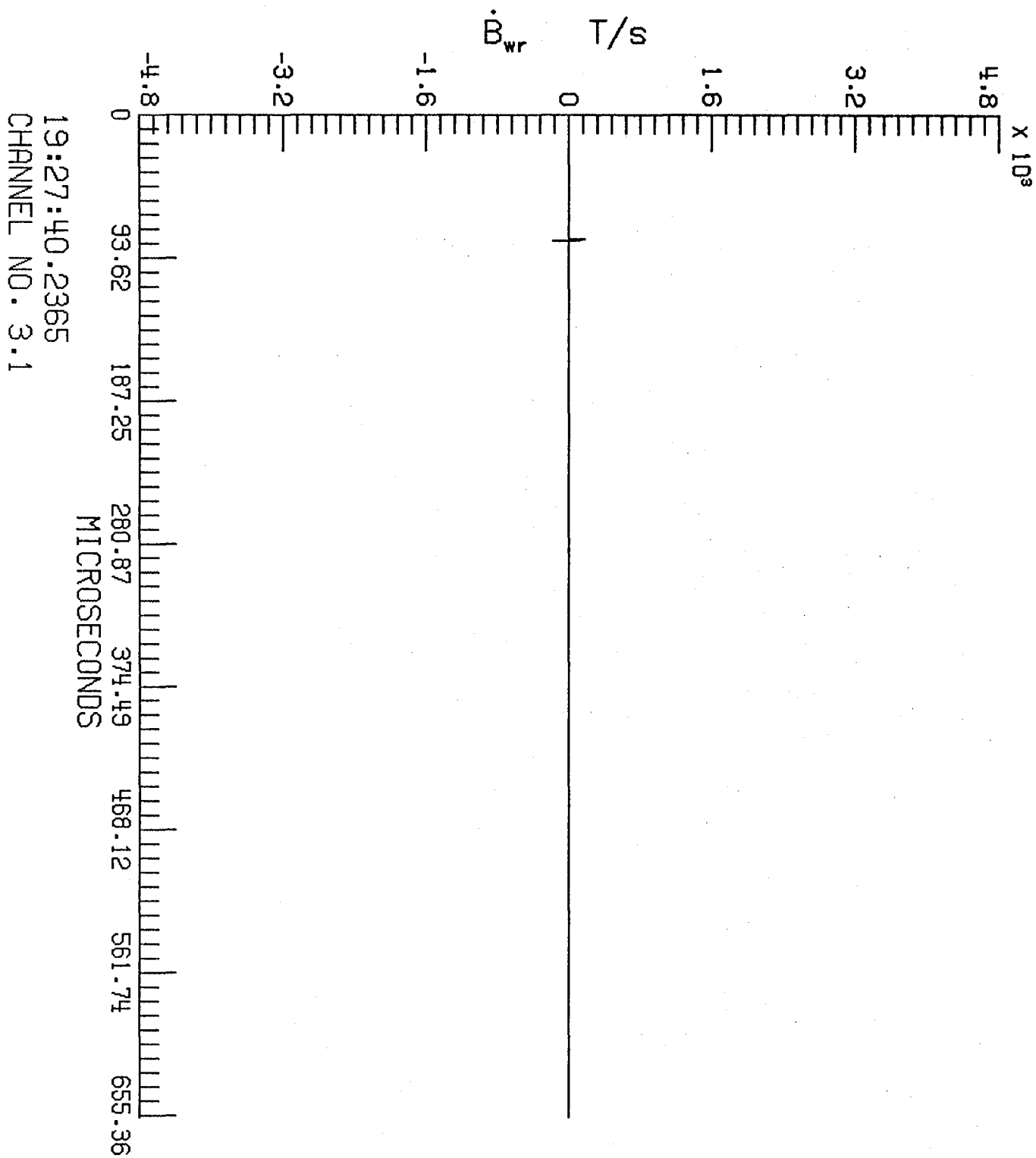
19:27:20.7149
CHANNEL NO. 3.1

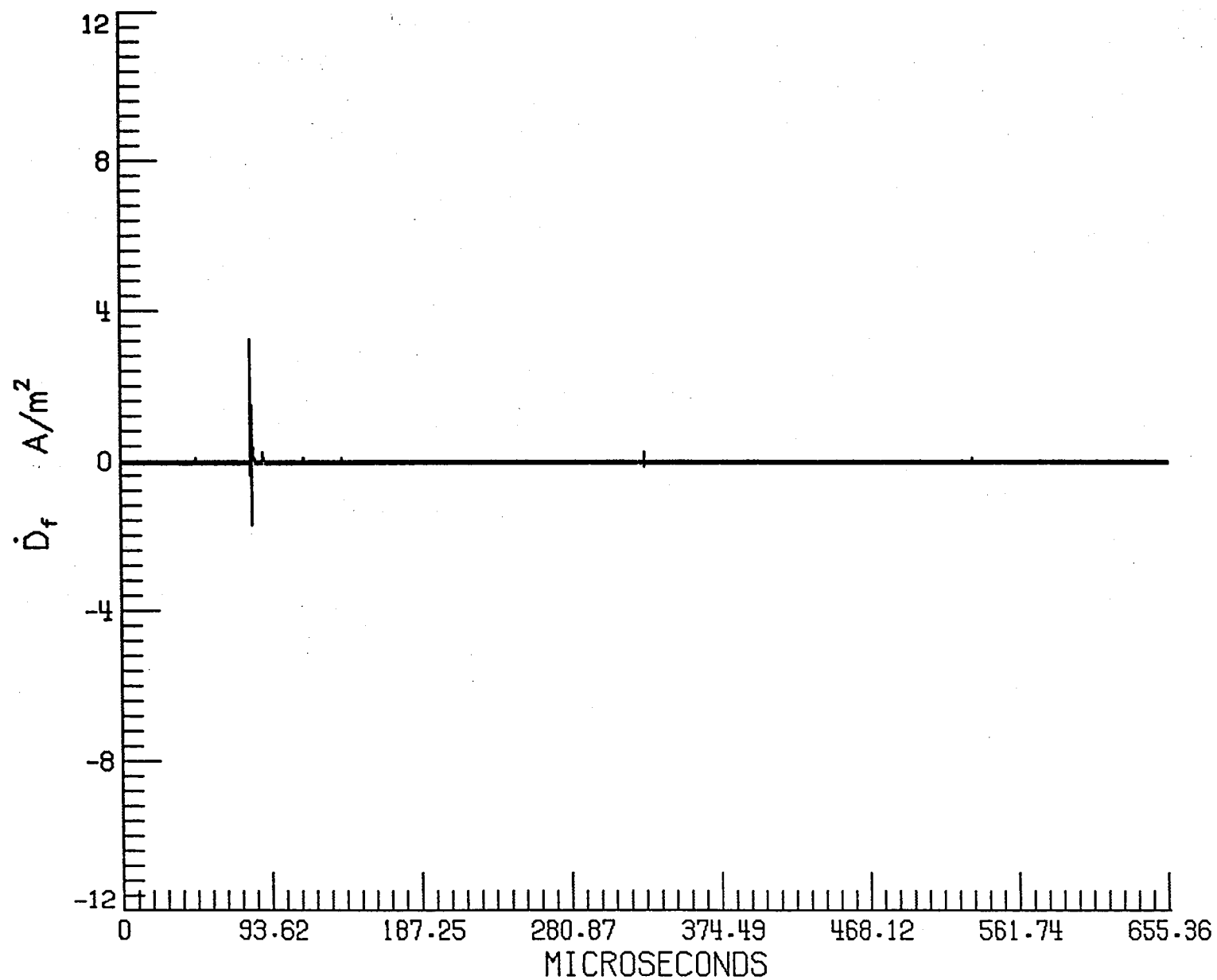




19:27:20.7231
CHANNEL NO. 4.1



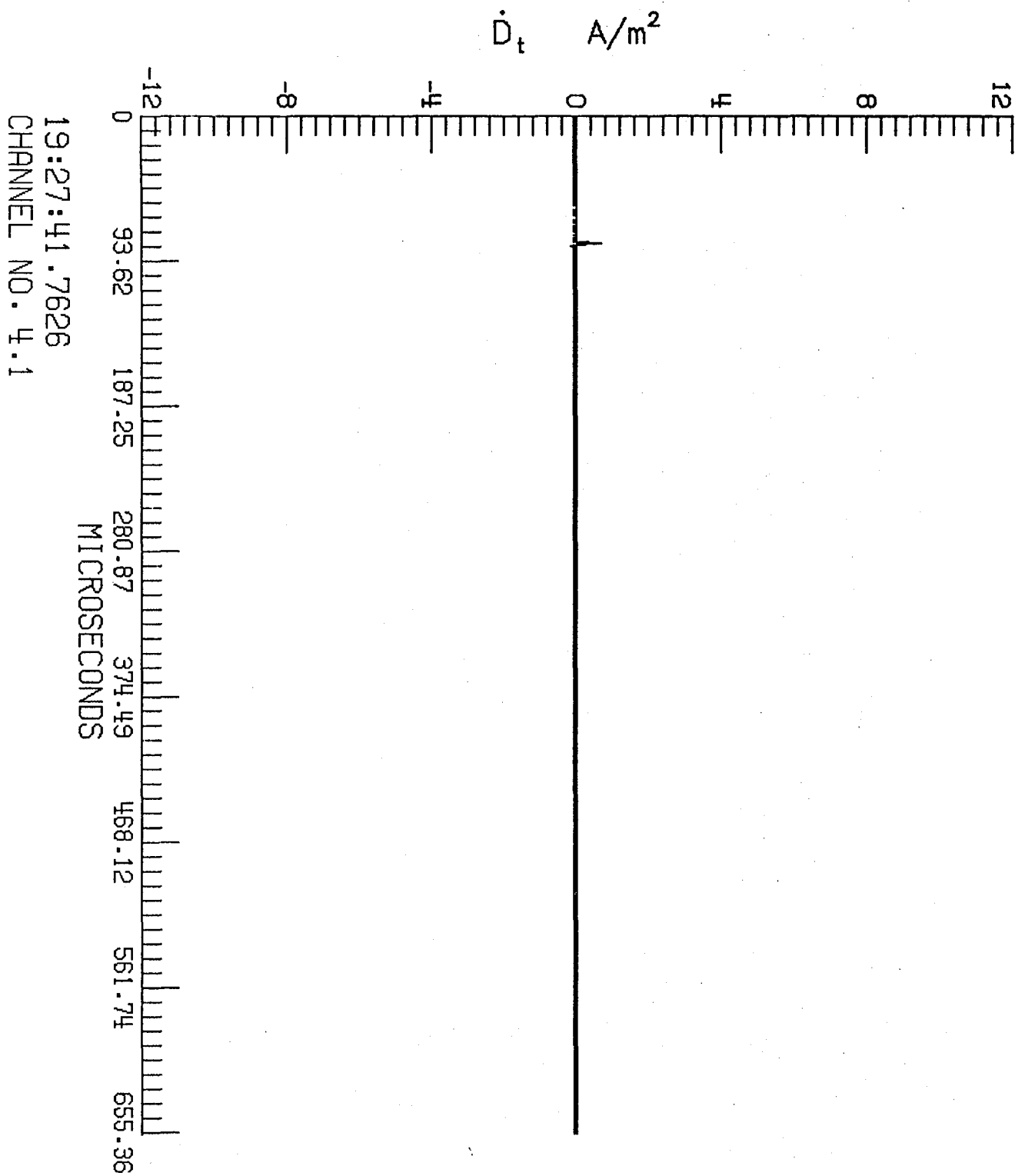


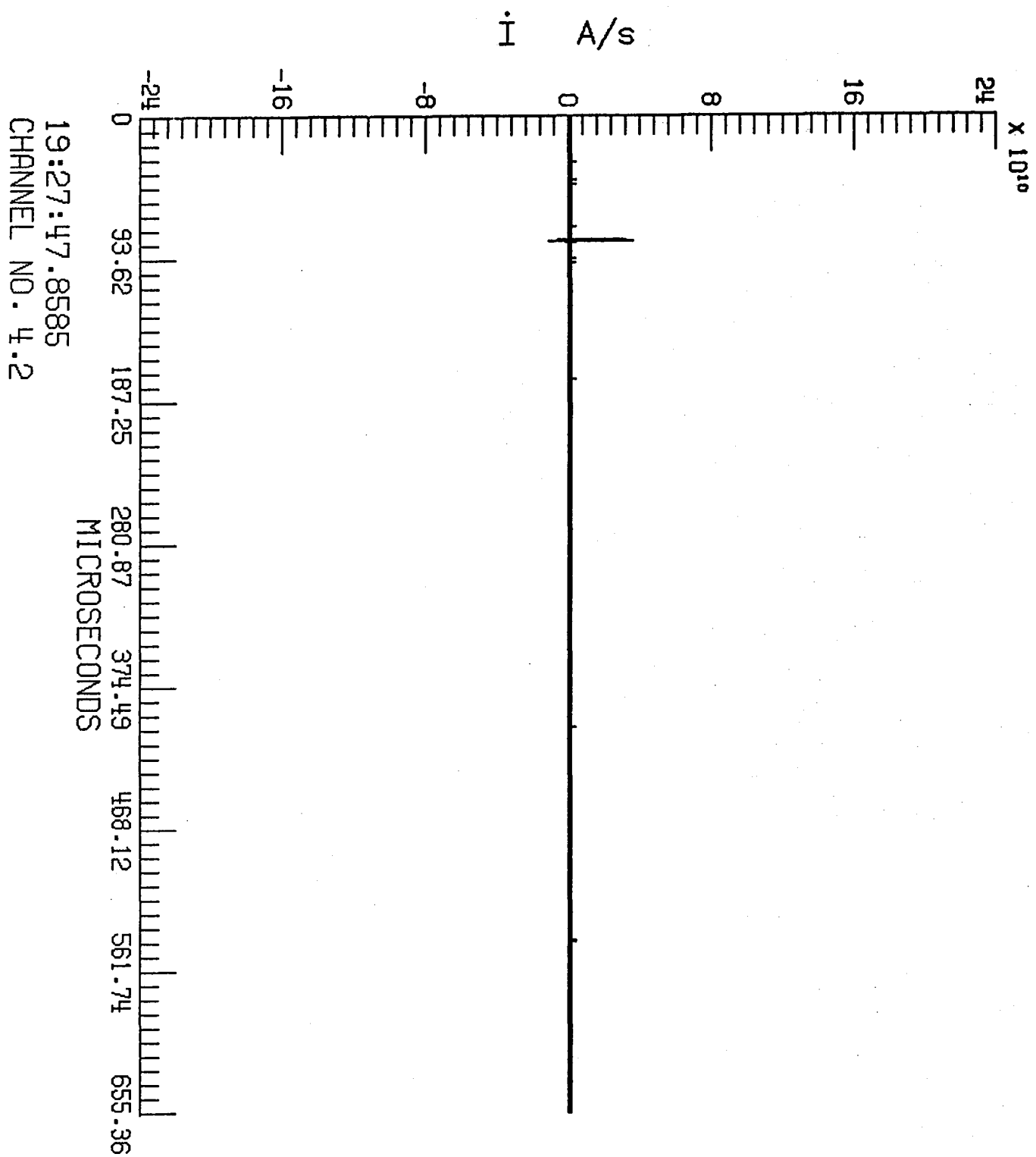


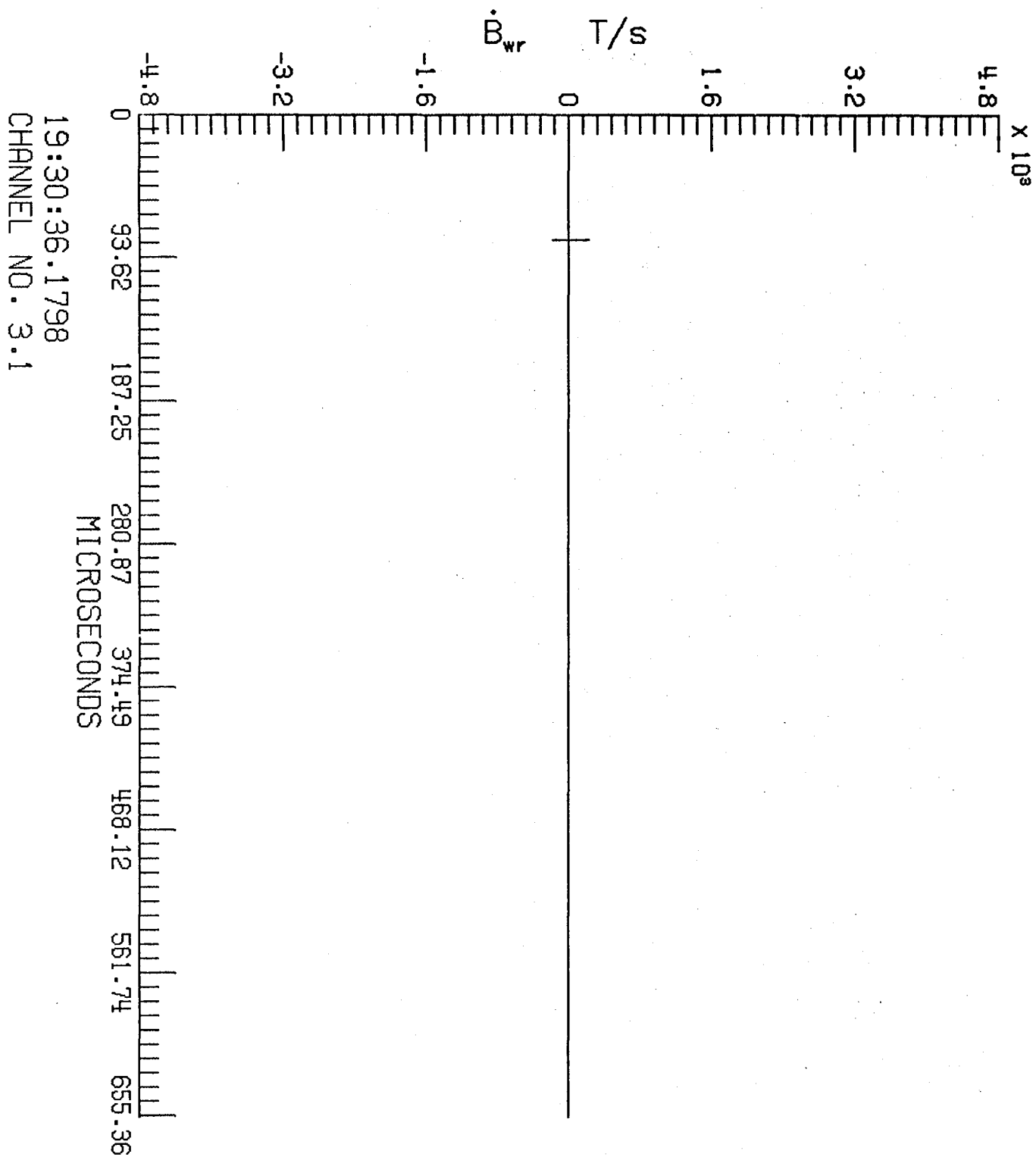
360

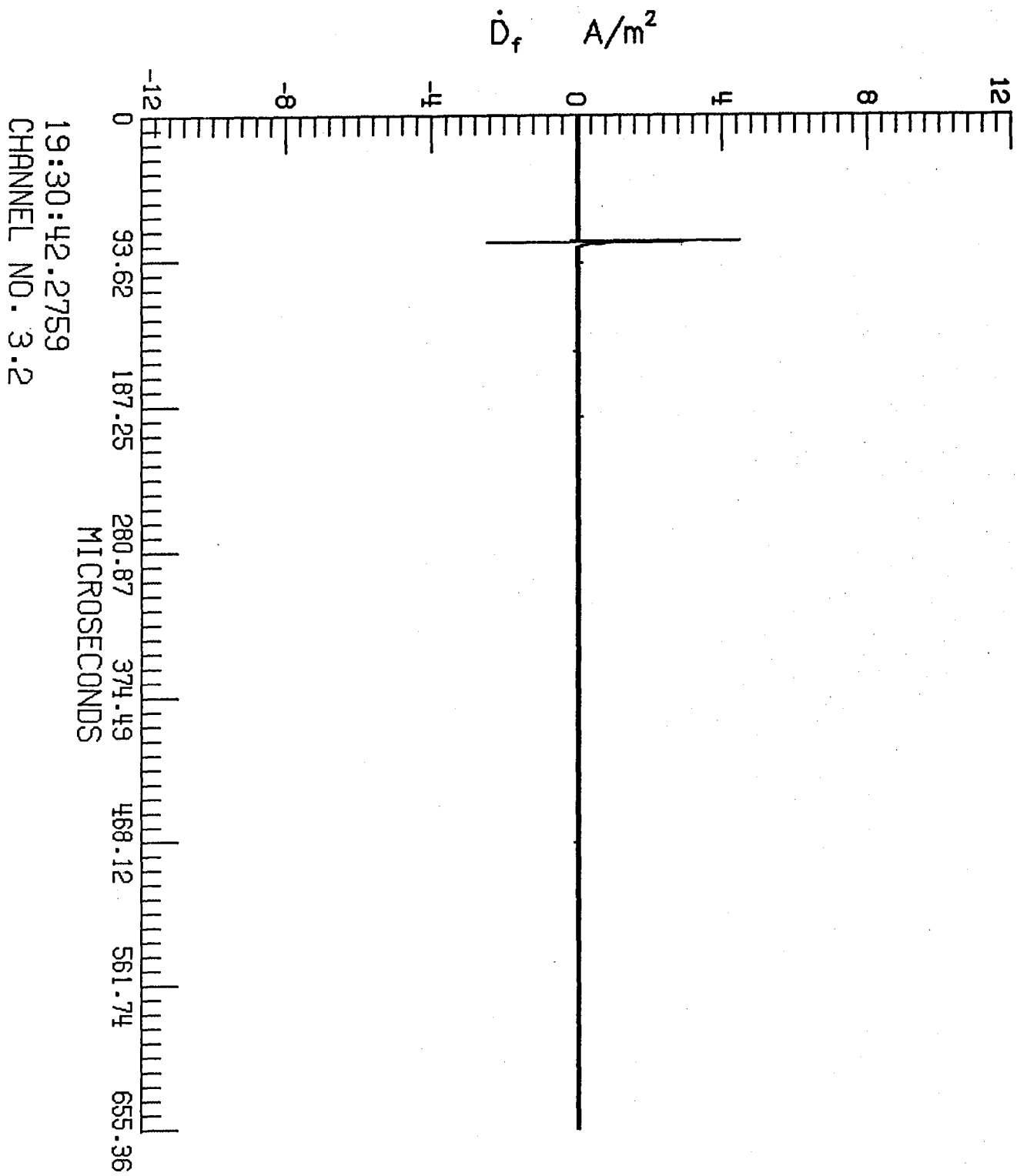
19:27:46.3326

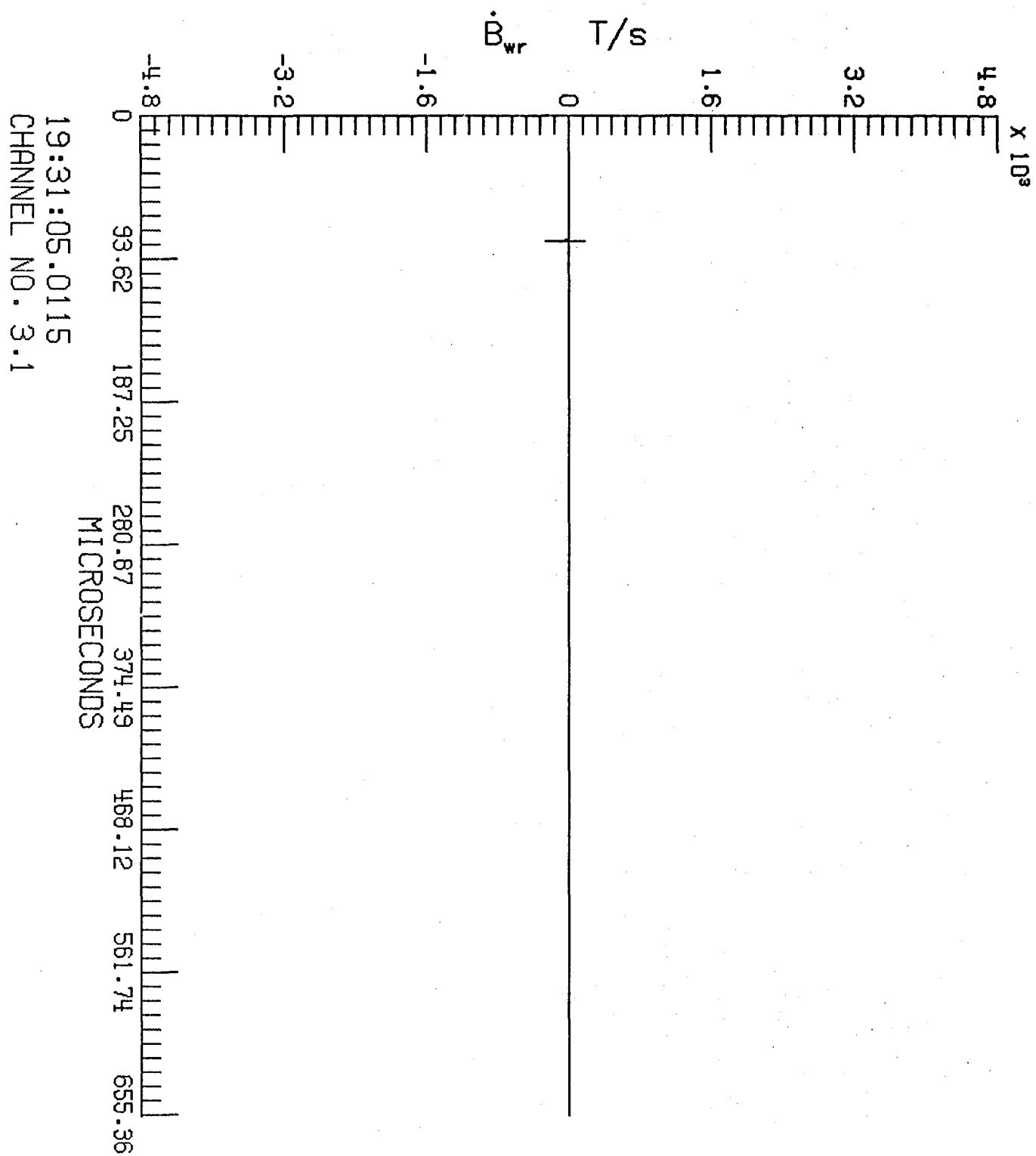
CHANNEL NO. 3.2

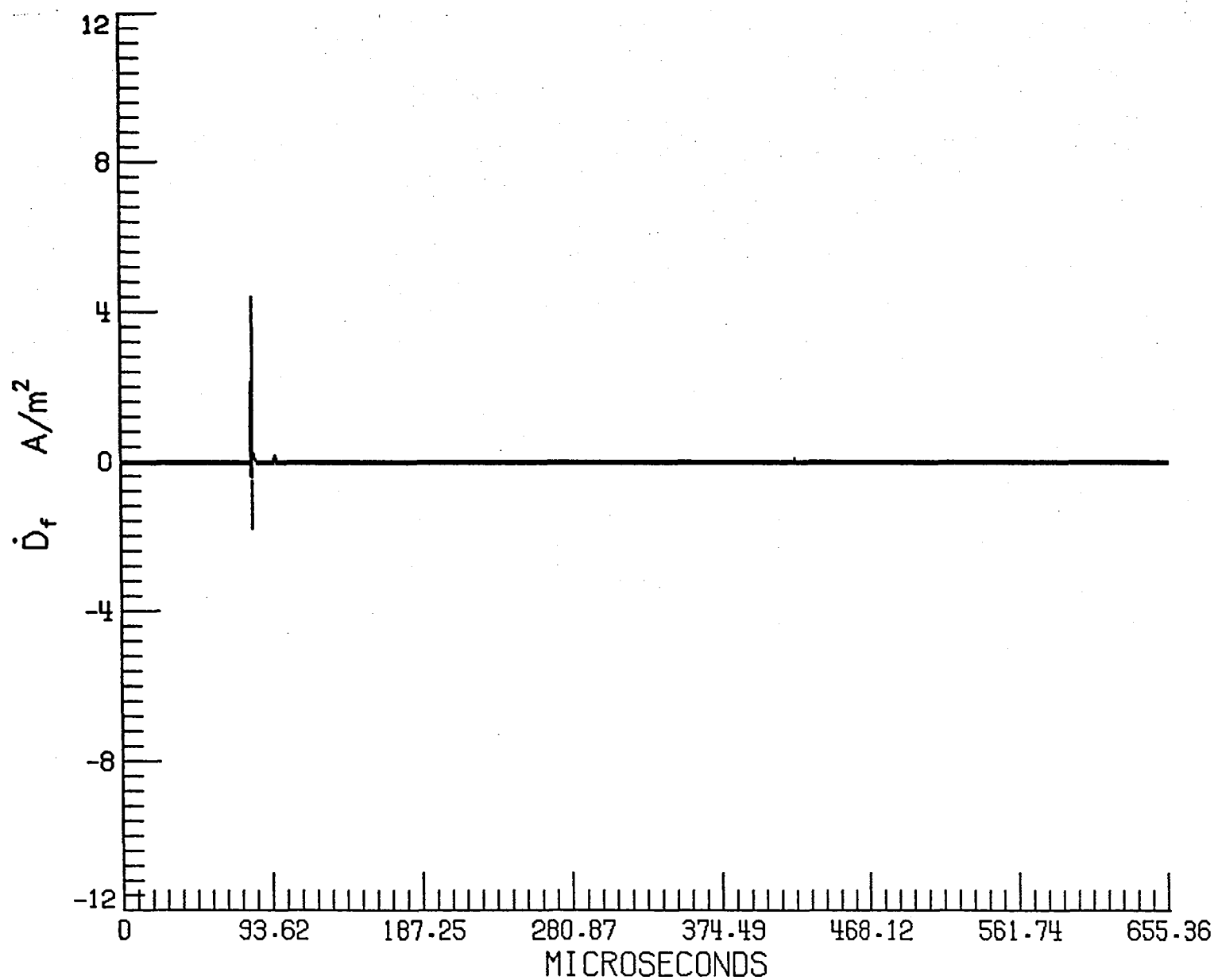






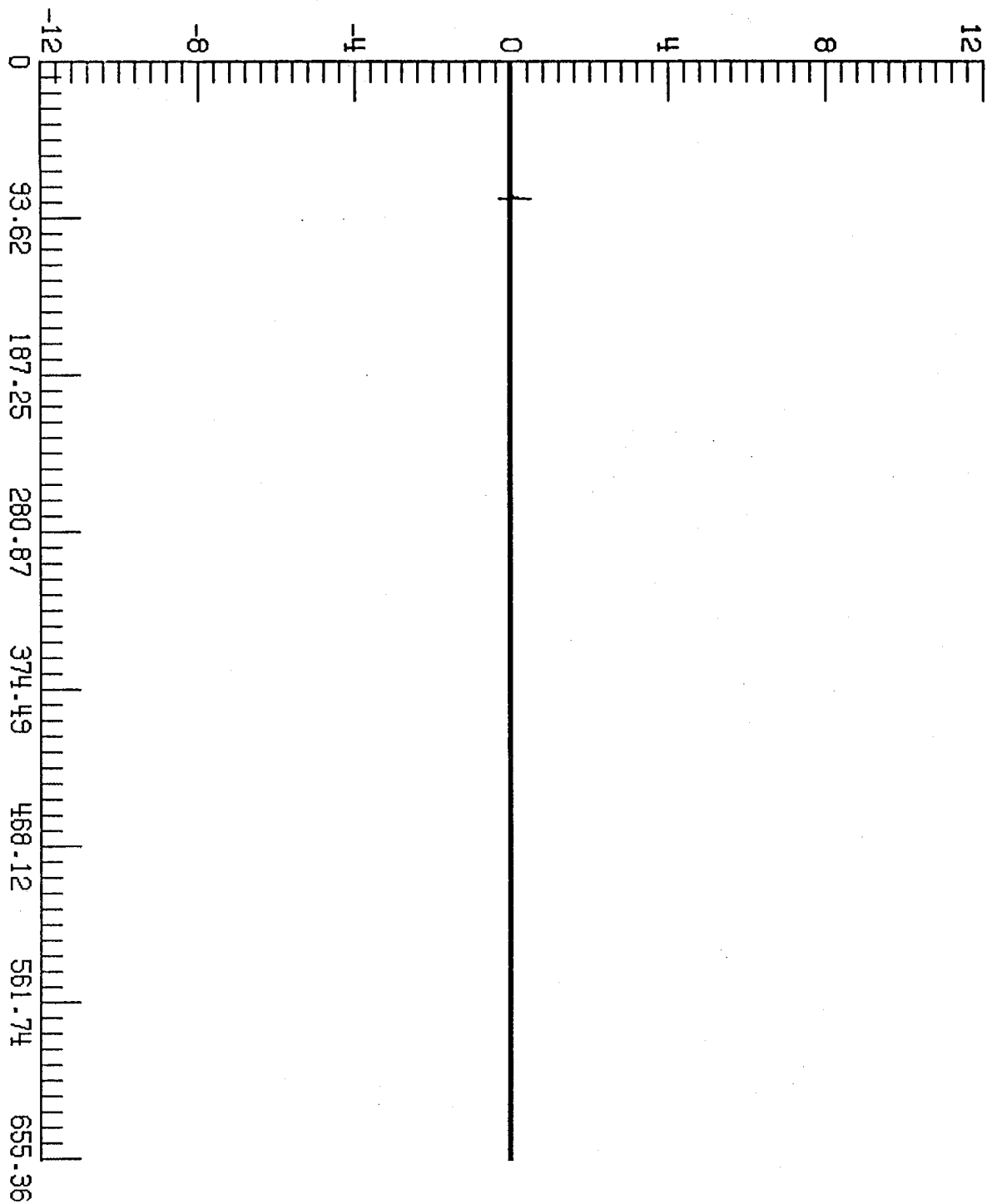




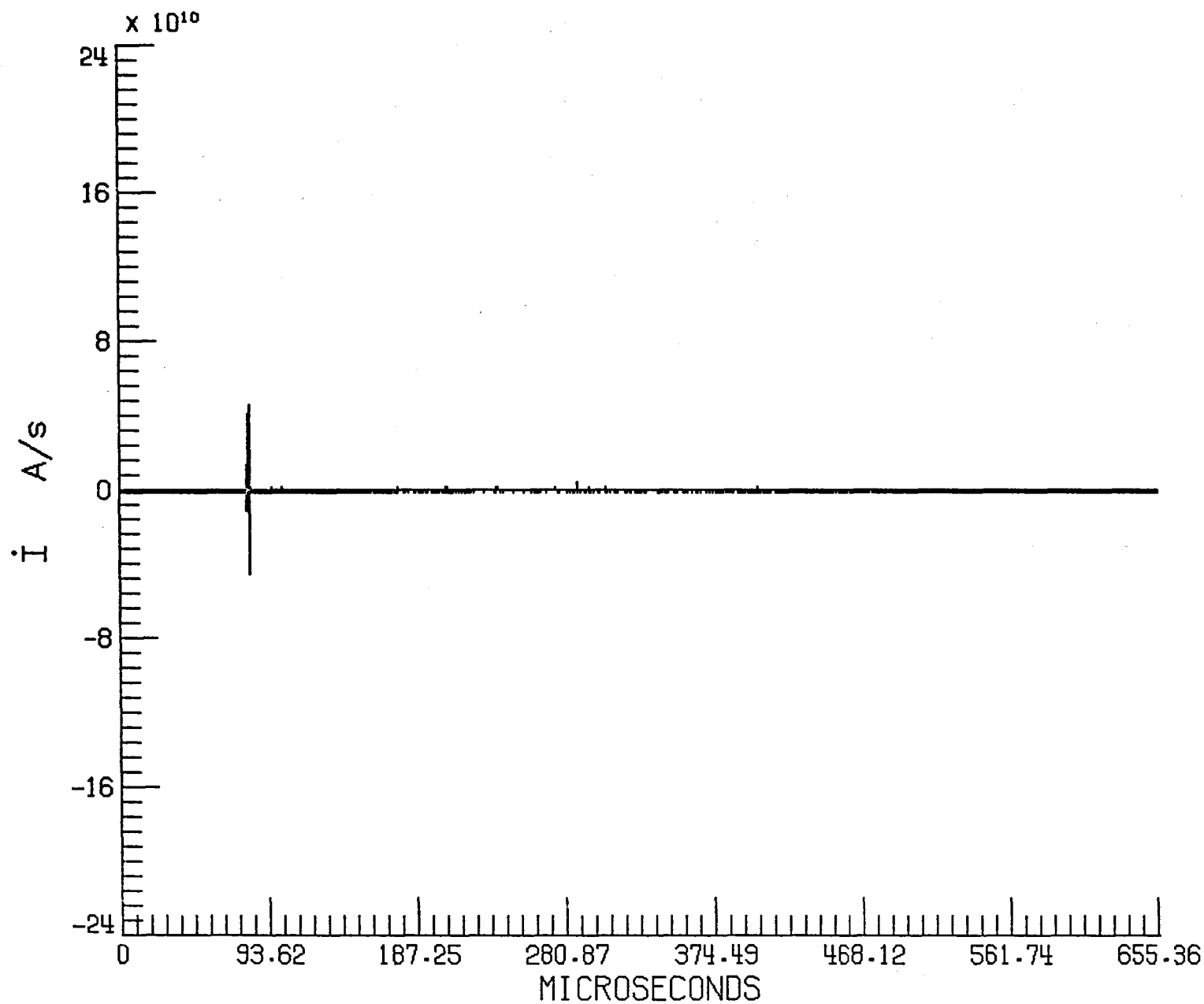


19:31:11.1076
CHANNEL NO. 3.2

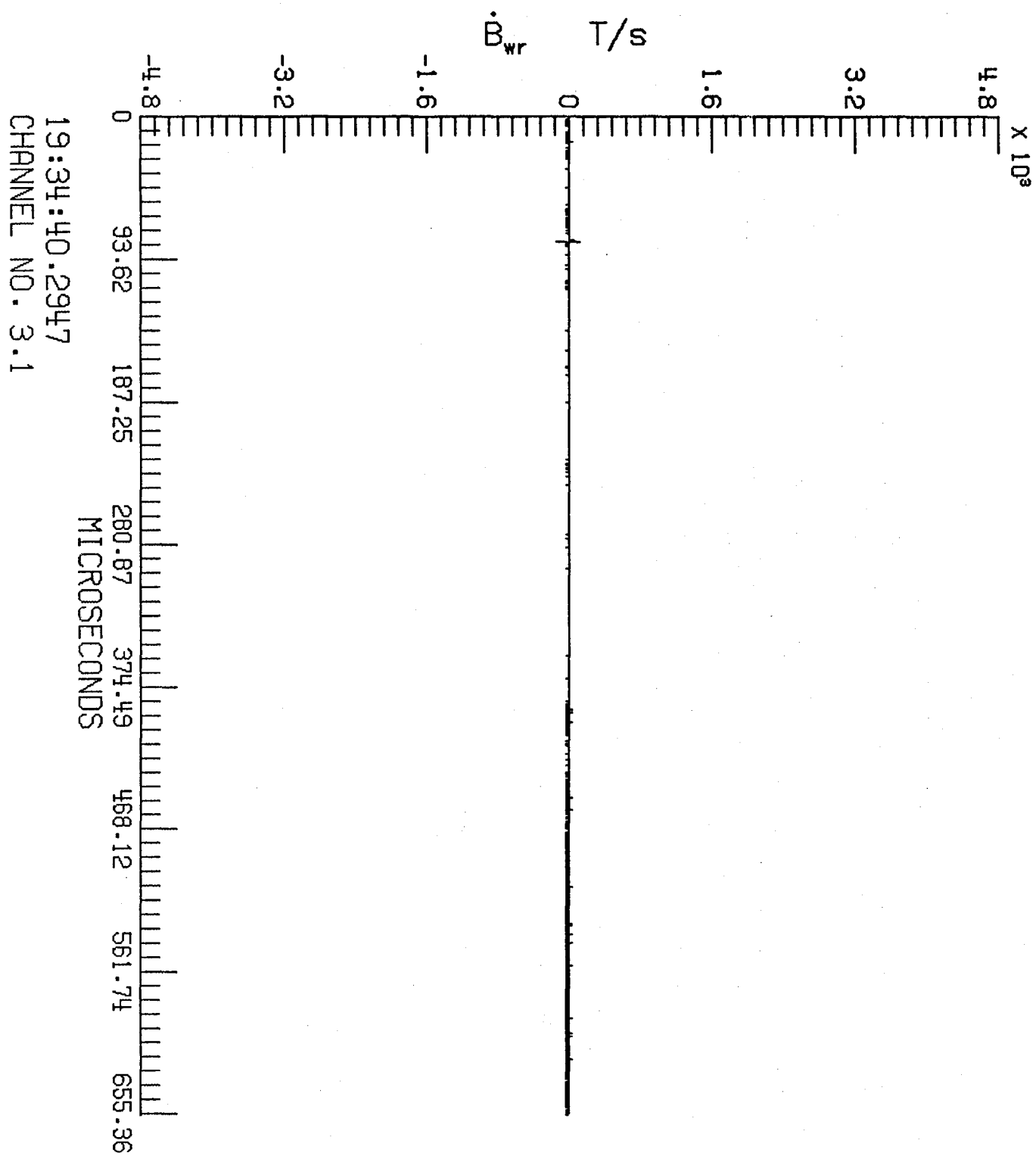
\dot{D}_t A/m^2

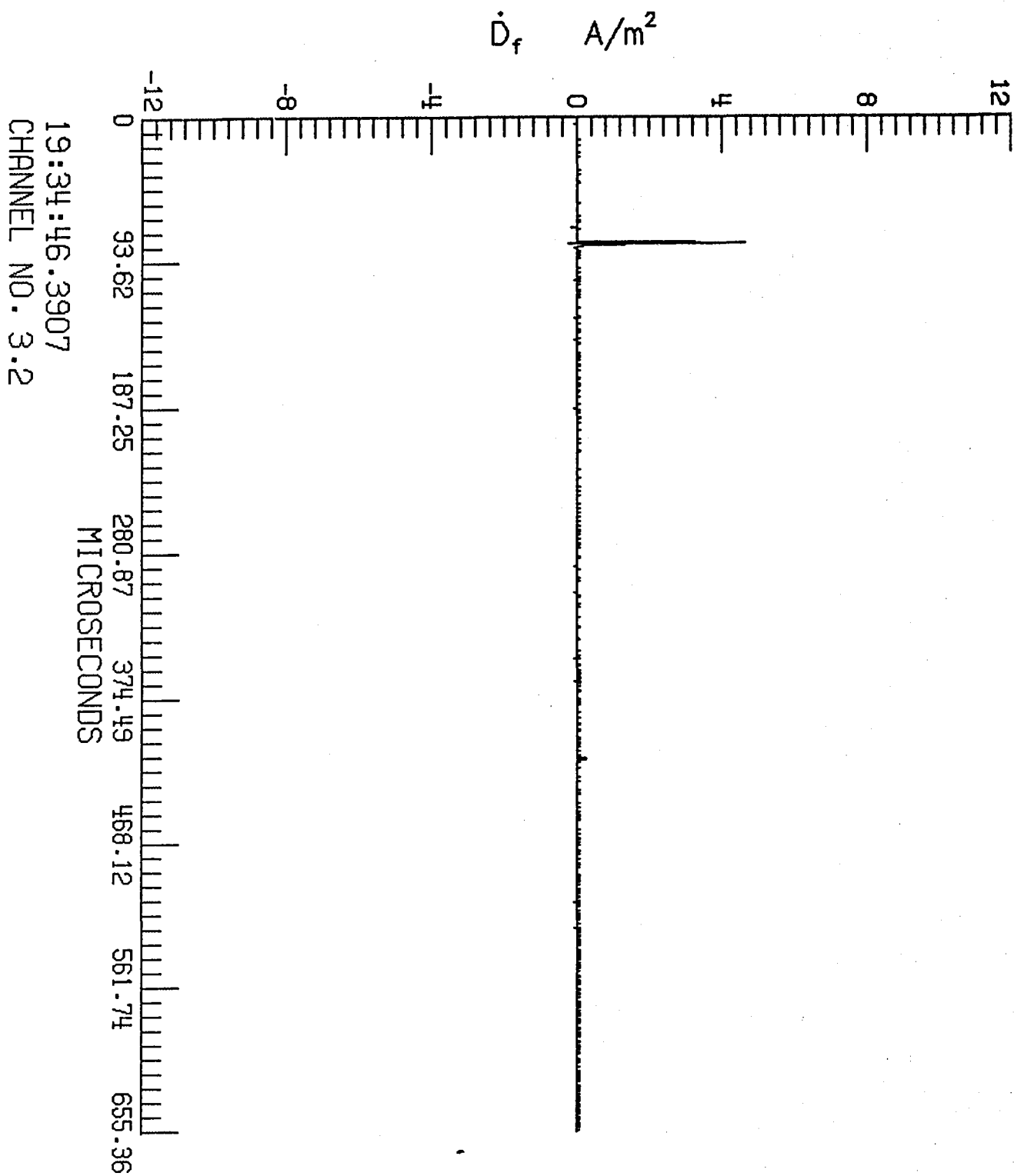


19:31:05.0770
CHANNEL NO. 4.1

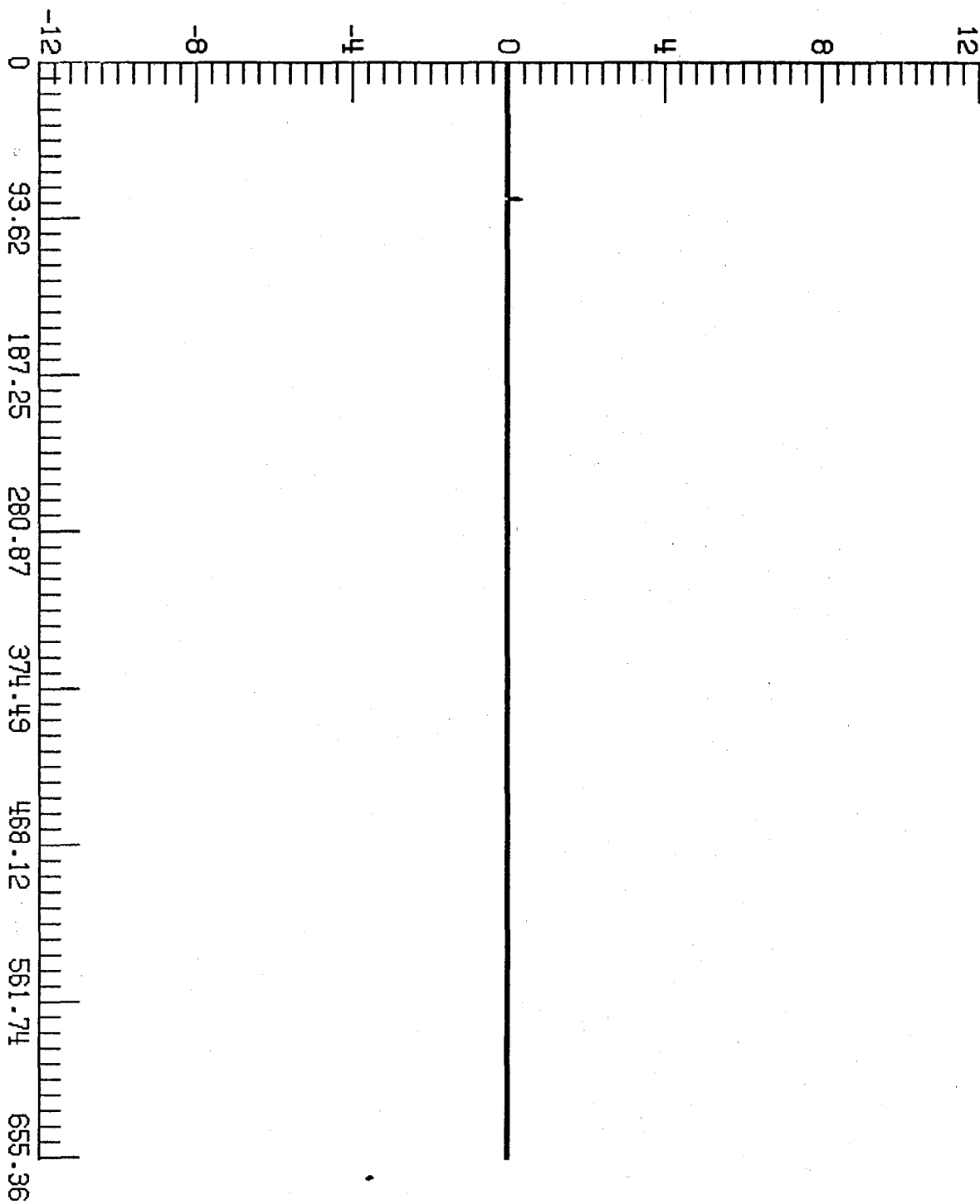


19:31:11.1730
CHANNEL NO. 4.2



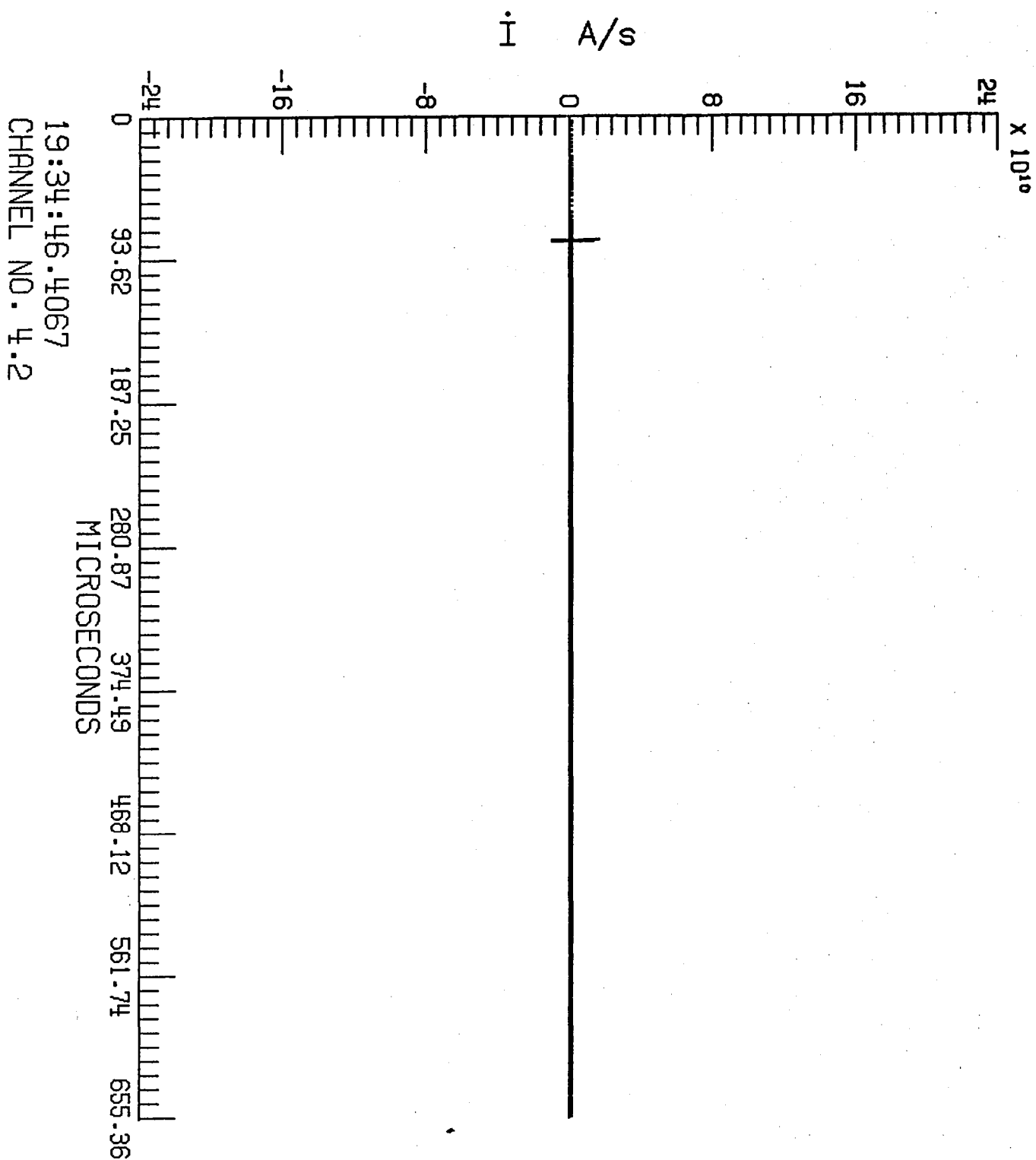


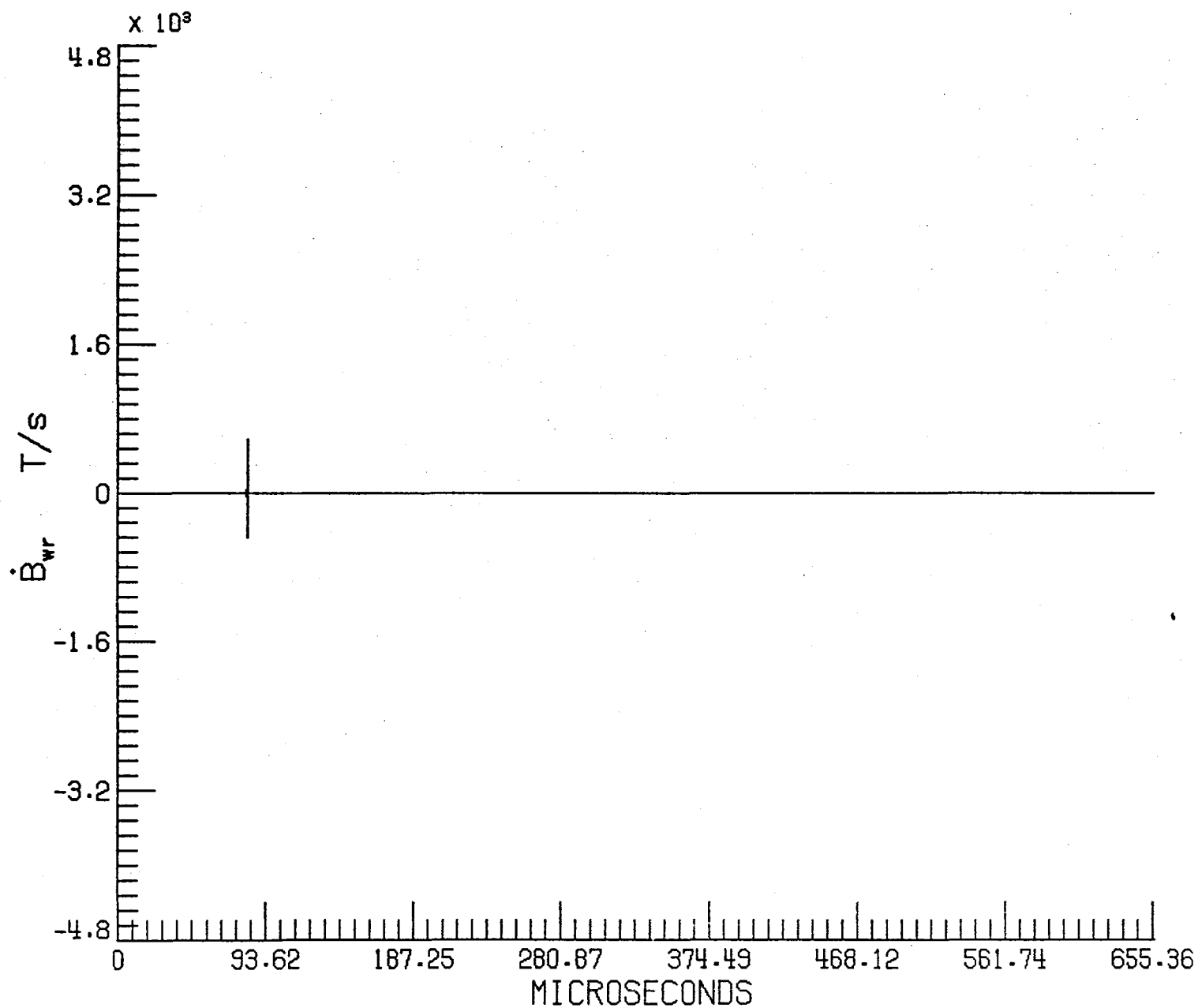
$\dot{D}_t \quad A/m^2$



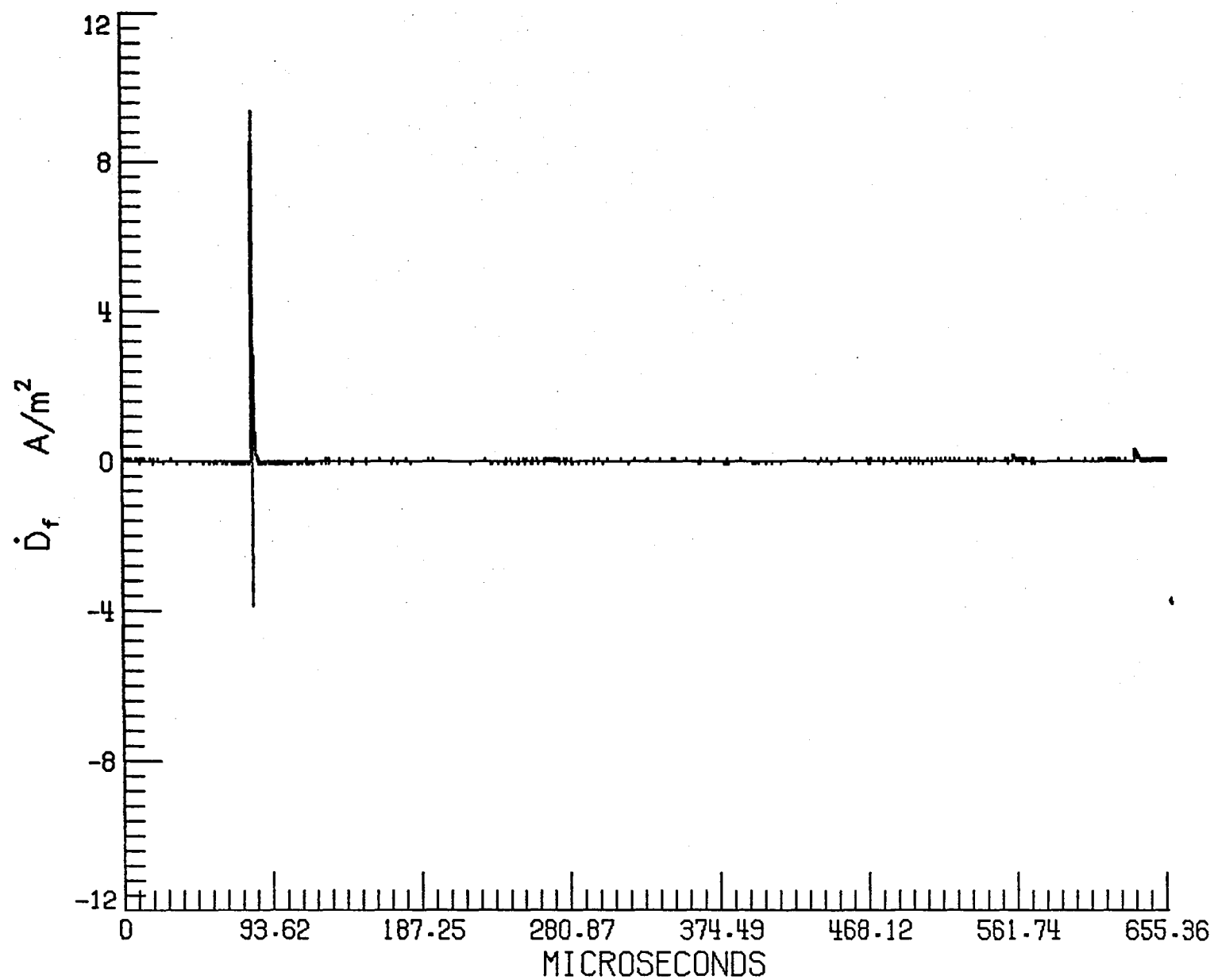
19:34:40.3107
CHANNEL NO. 4.1

MICROSECONDS



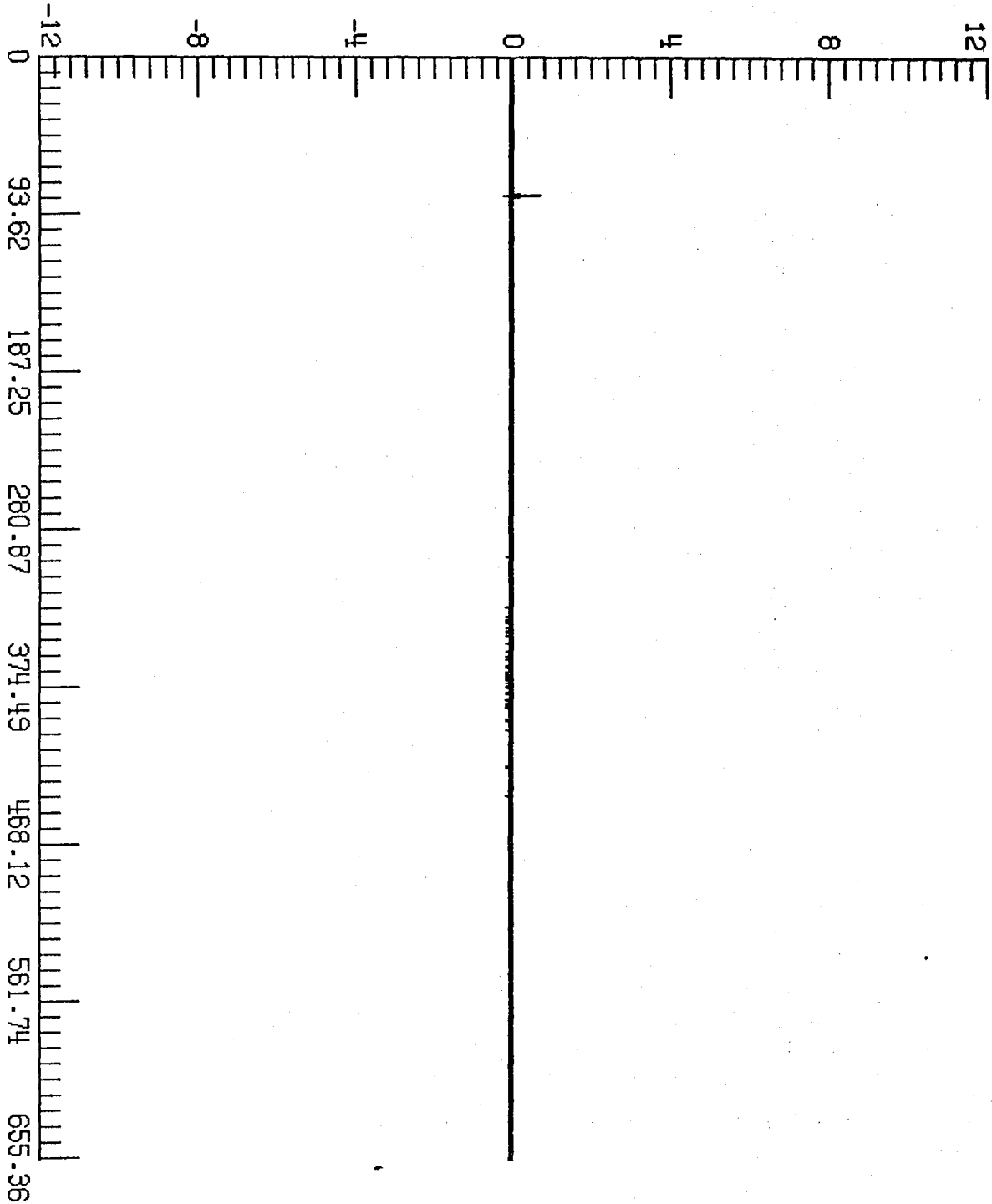


22:06:37.6364
CHANNEL NO. 3.1

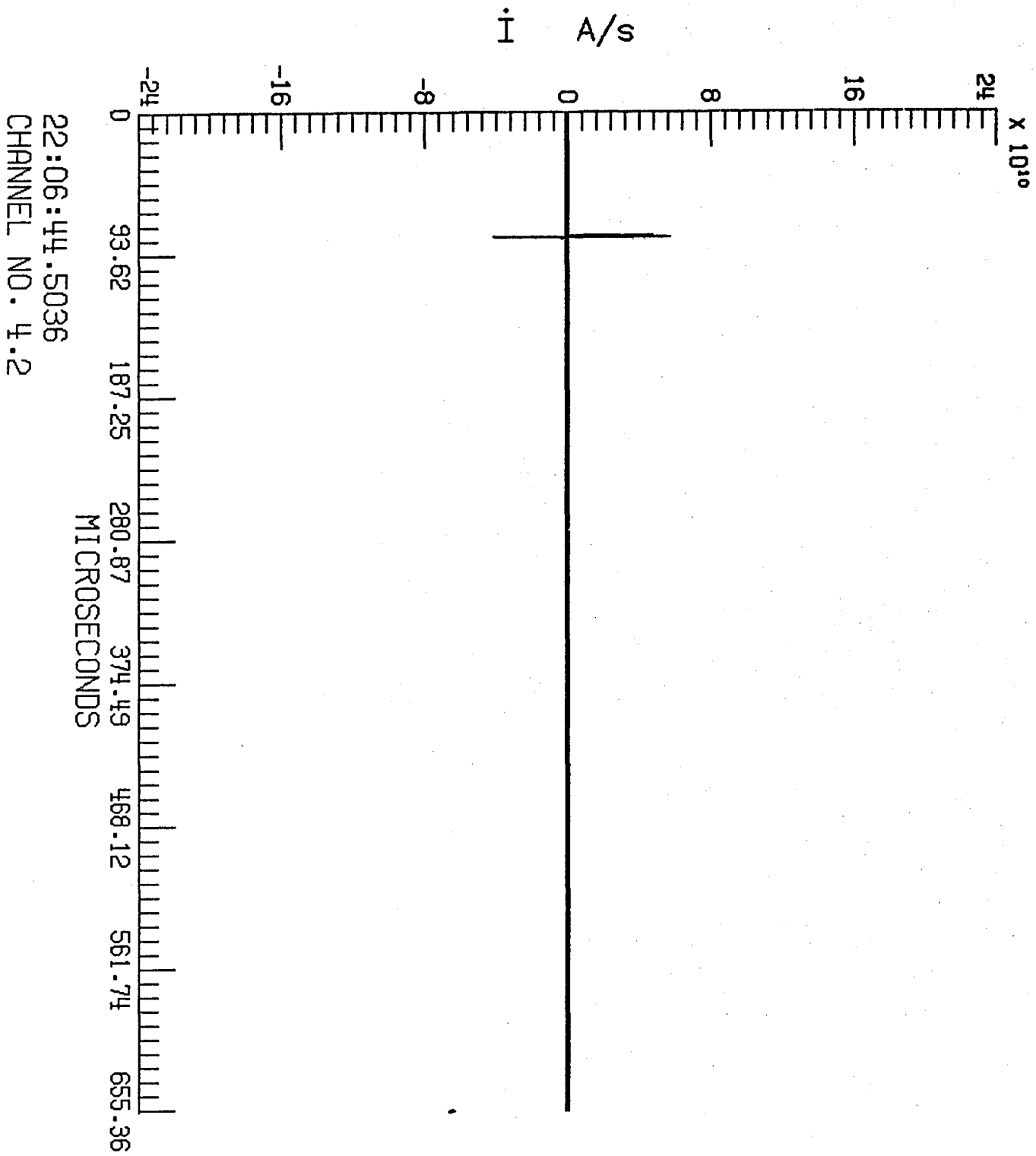


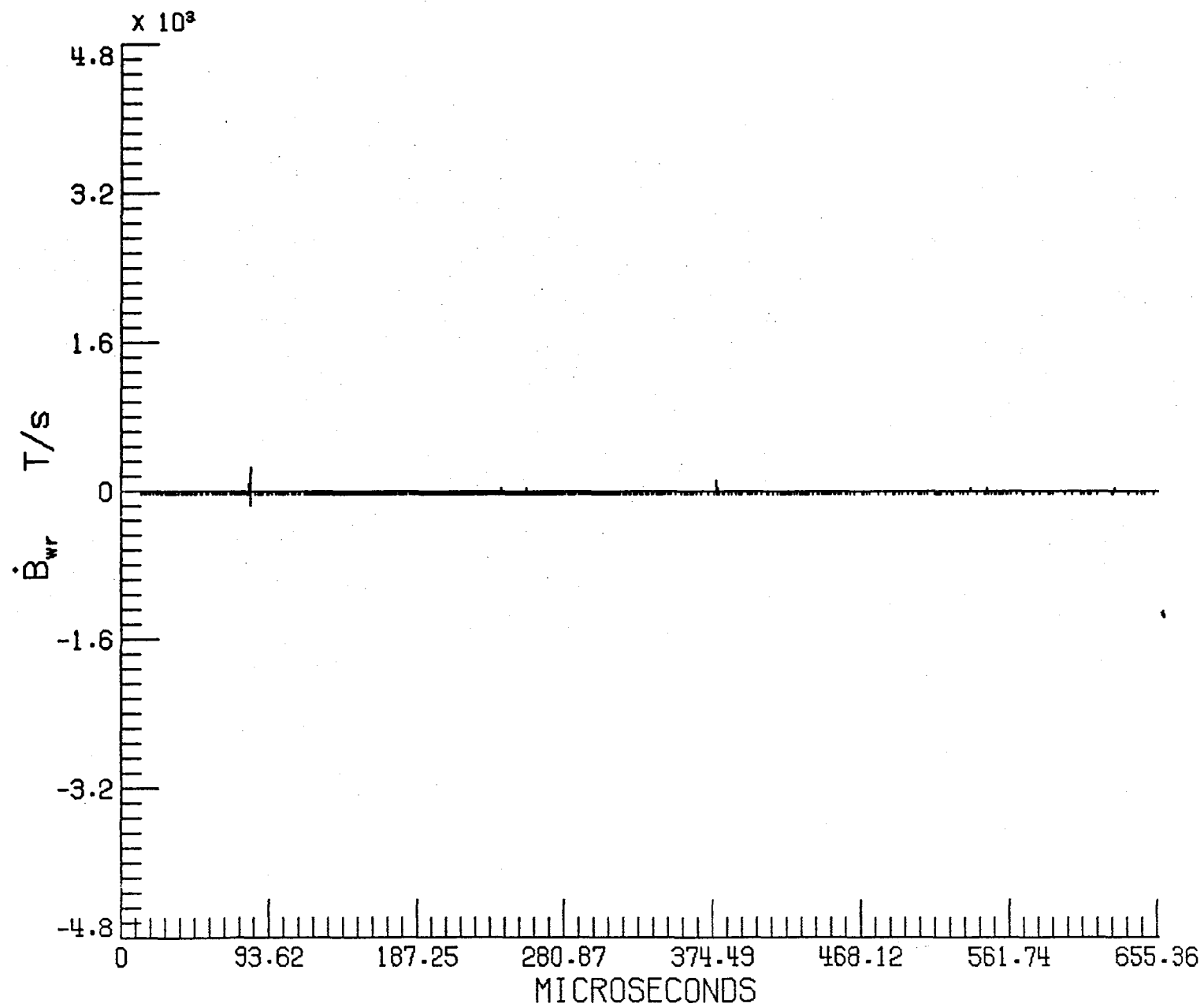
22:06:43.7324
CHANNEL NO. 3.2

\dot{D}_t A/m²



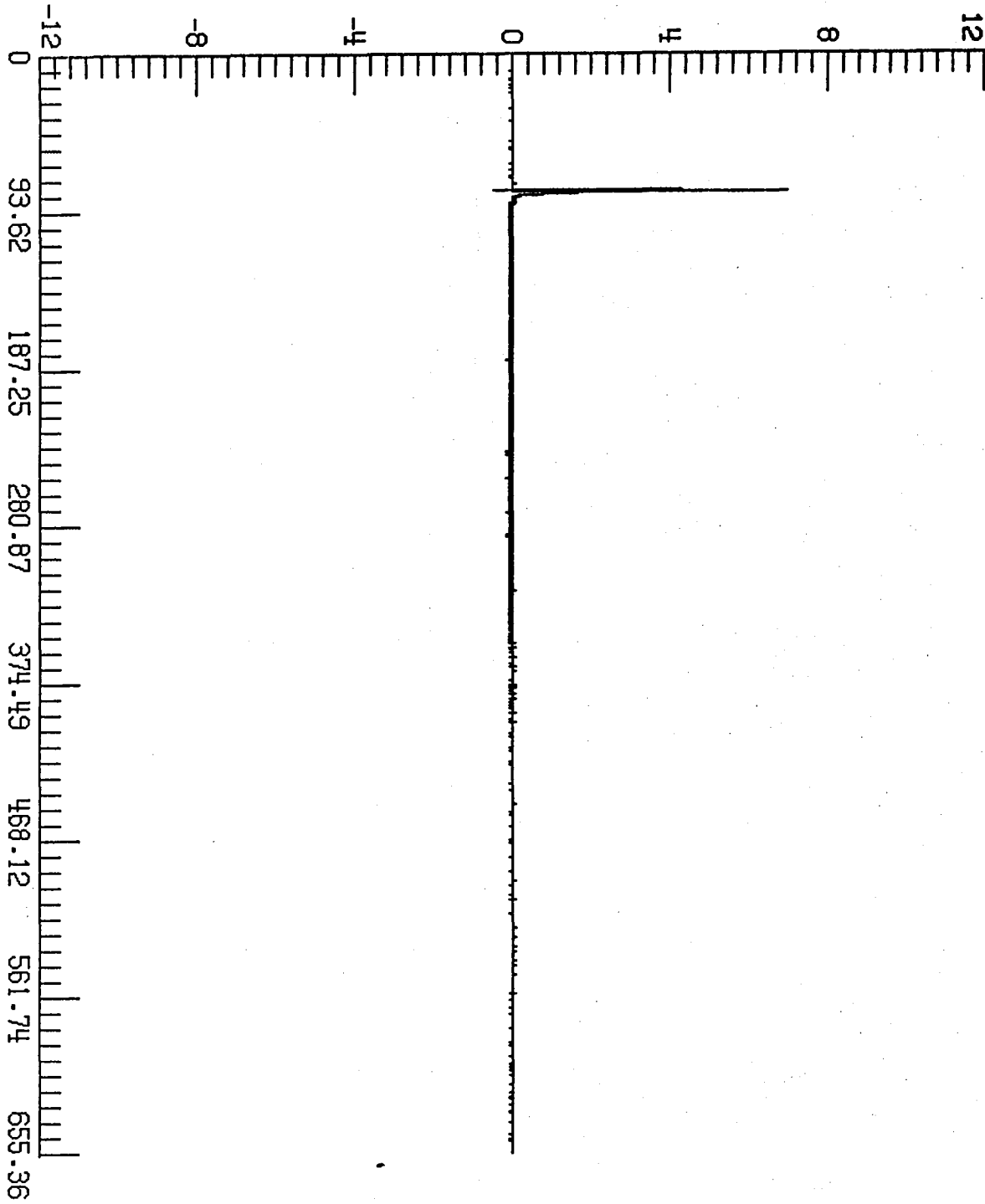
22:06:38.4077
CHANNEL NO. 4.1





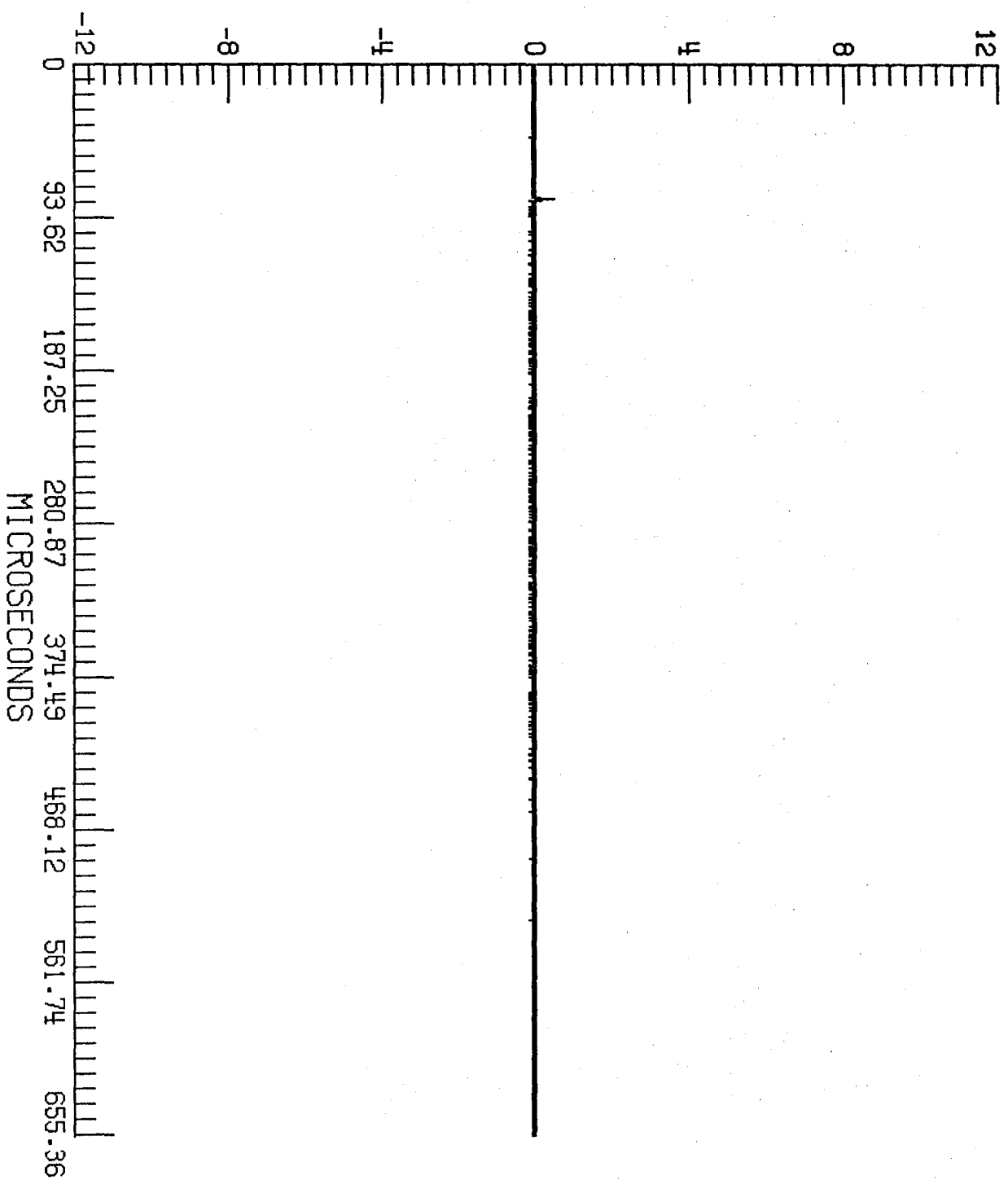
22:07:03.8708
CHANNEL NO. 3.1

\dot{D}_f A/m²



22:07:09.9550
CHANNEL NO. 3.2

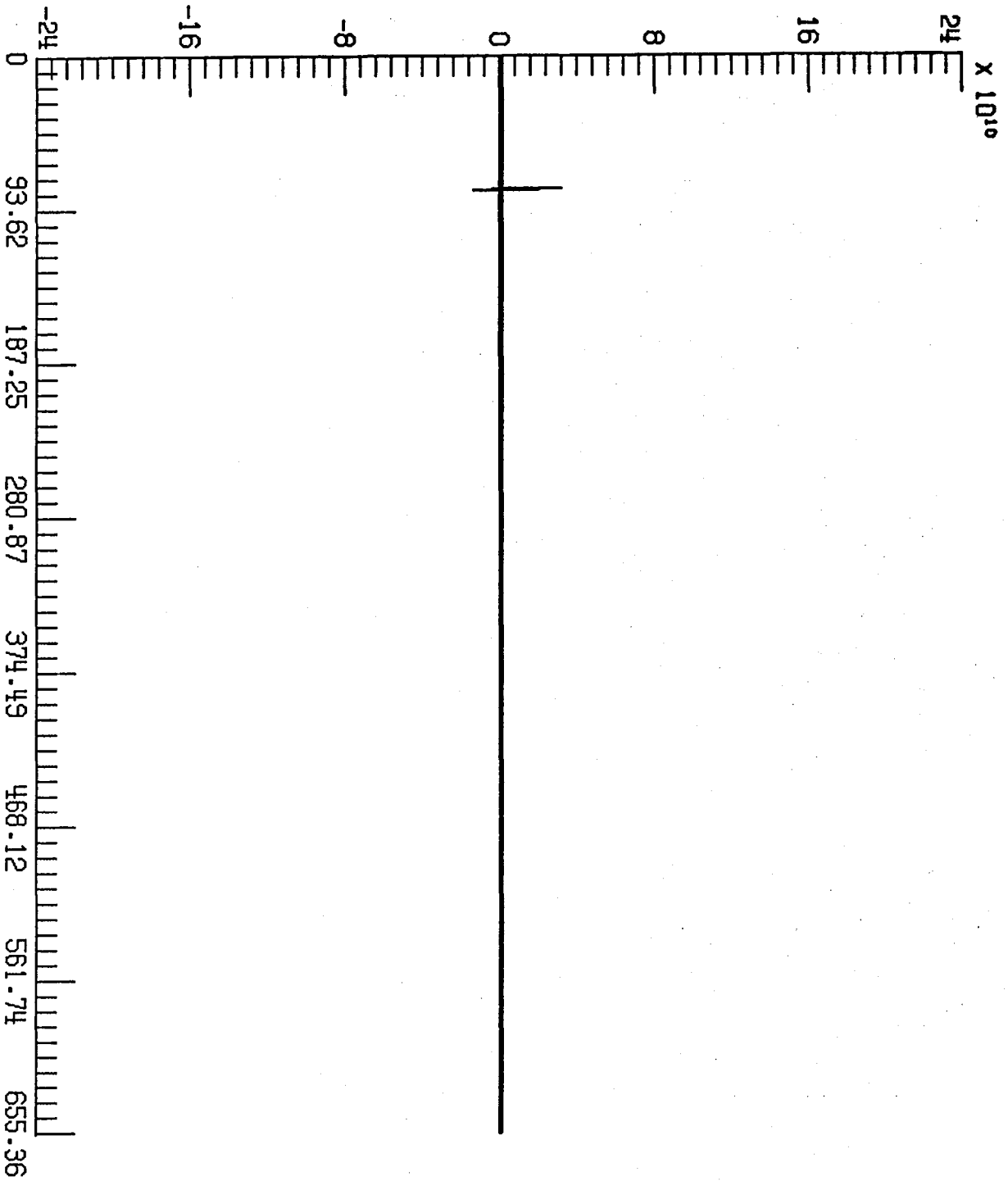
\dot{D}_t A/m^2

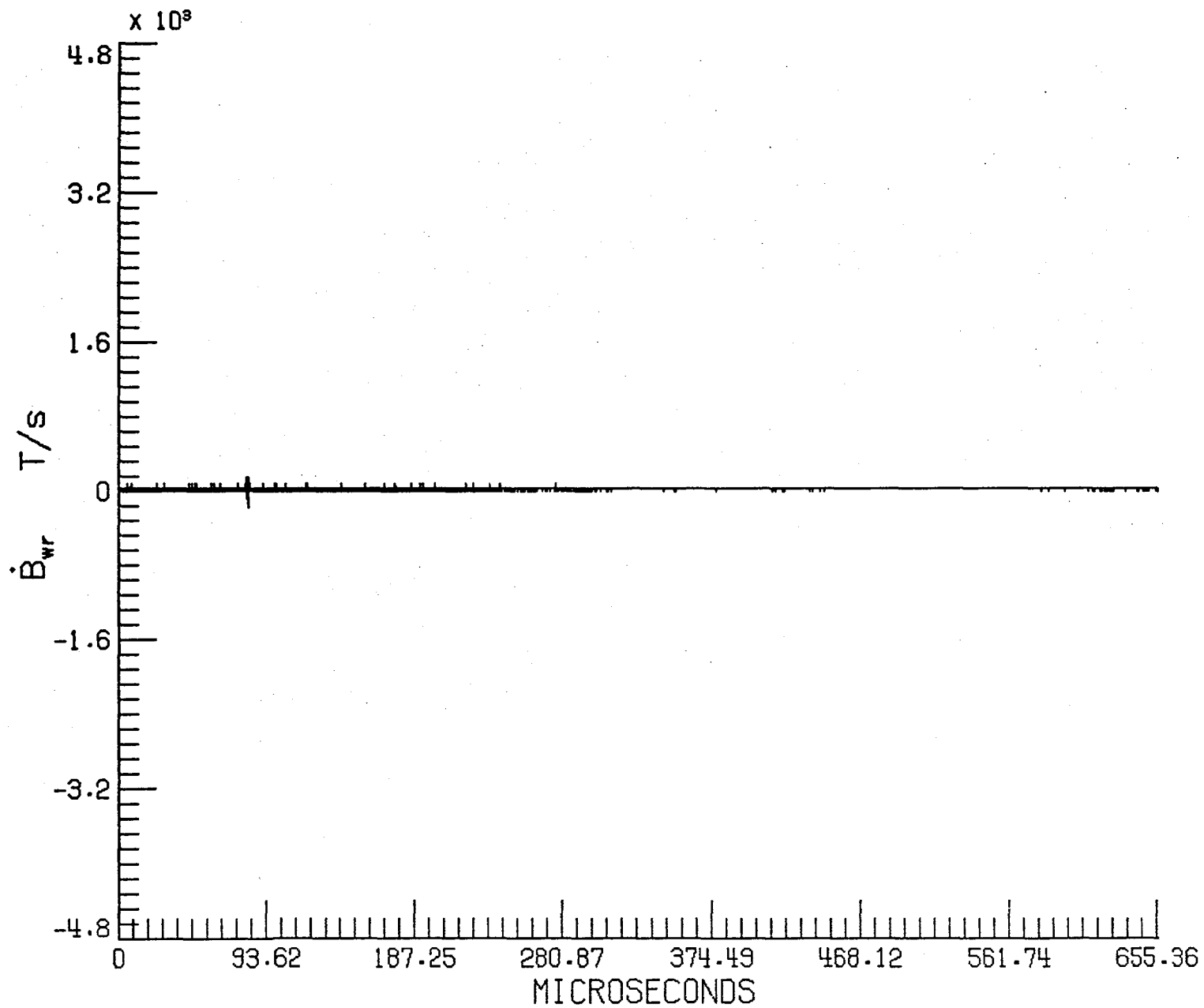


22:07:03.8828
CHANNEL NO. 4.1

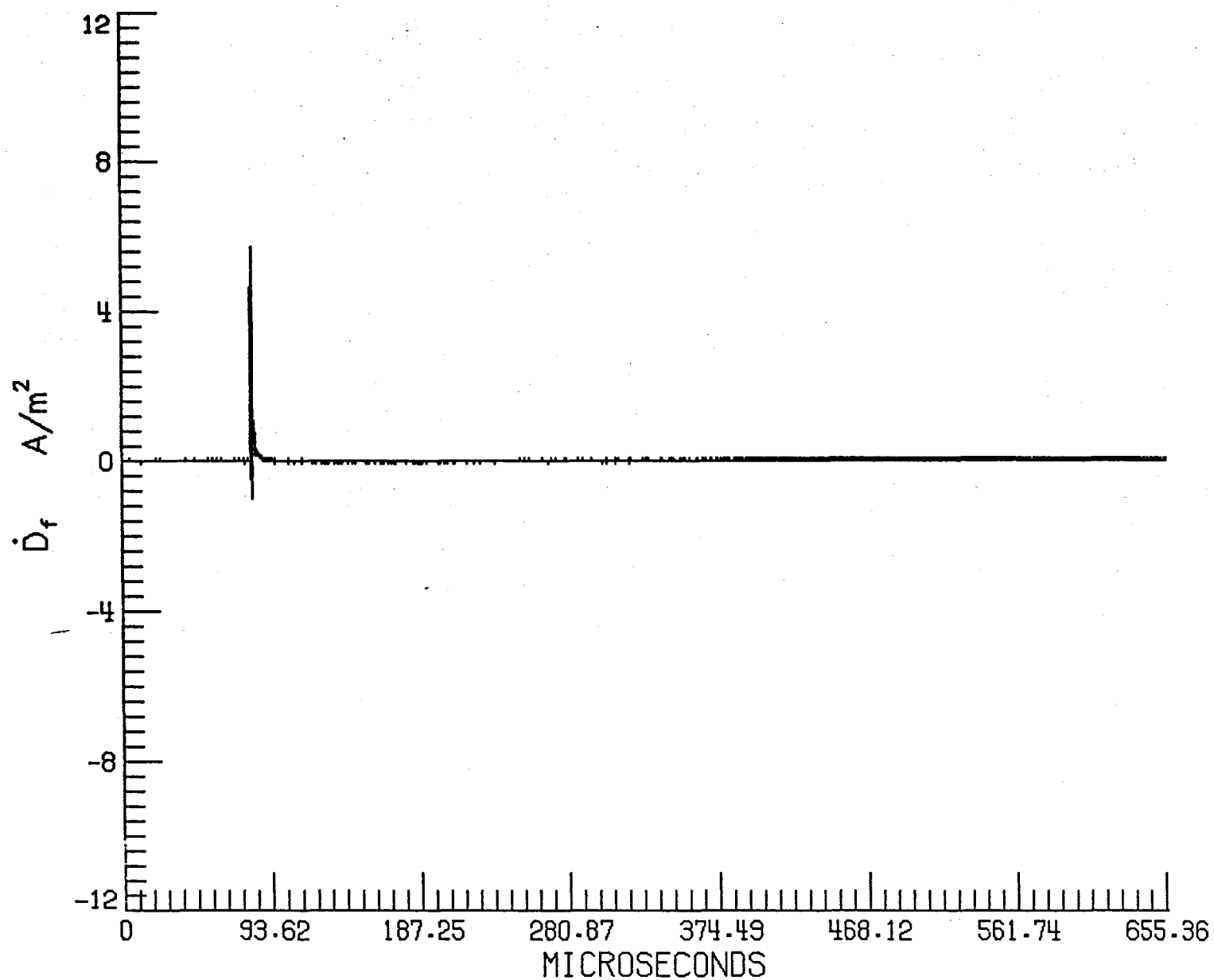
22:07:09.9788
CHANNEL NO. 4.2

MICROSECONDS



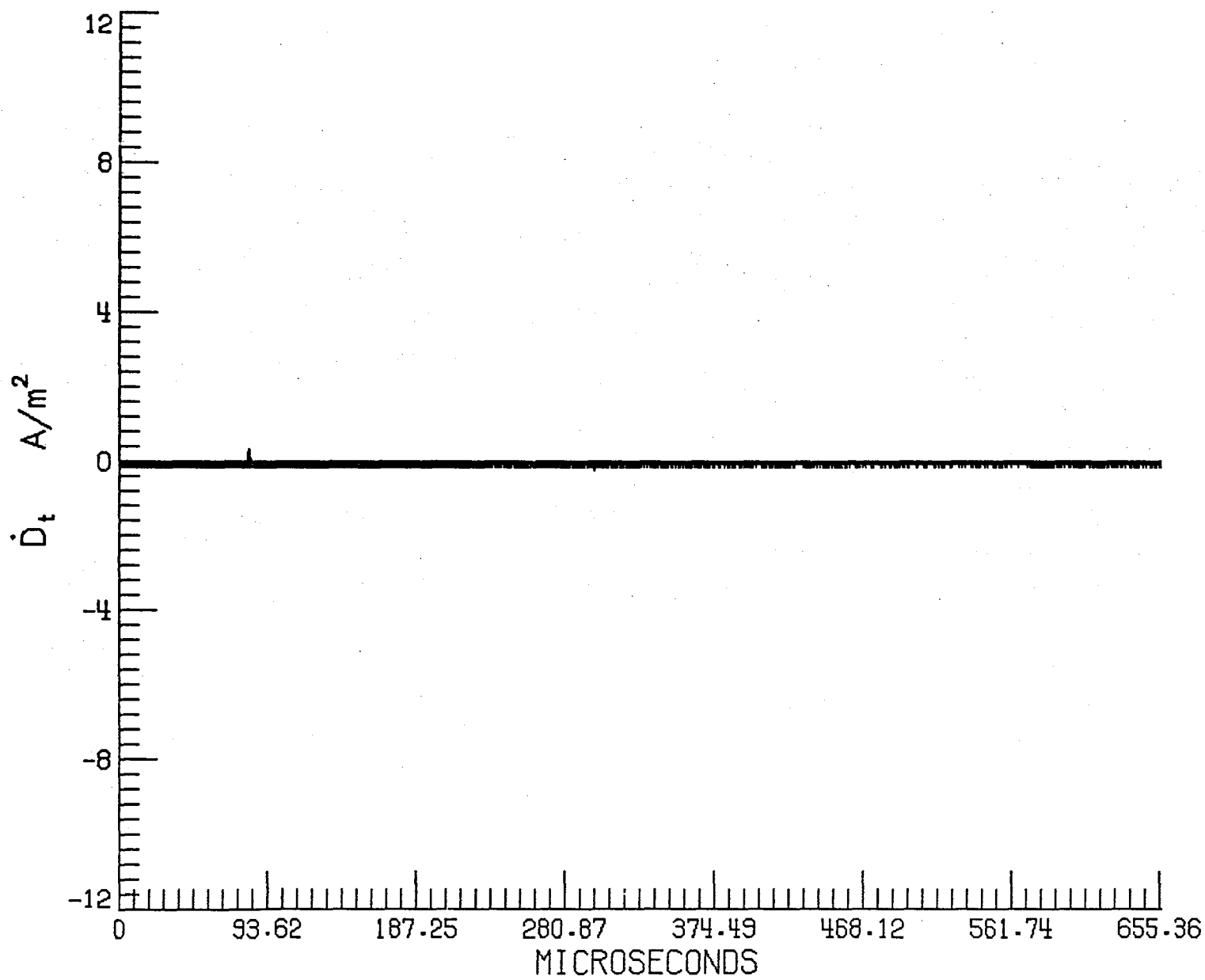


22:10:55.7467
CHANNEL NO. 3.1



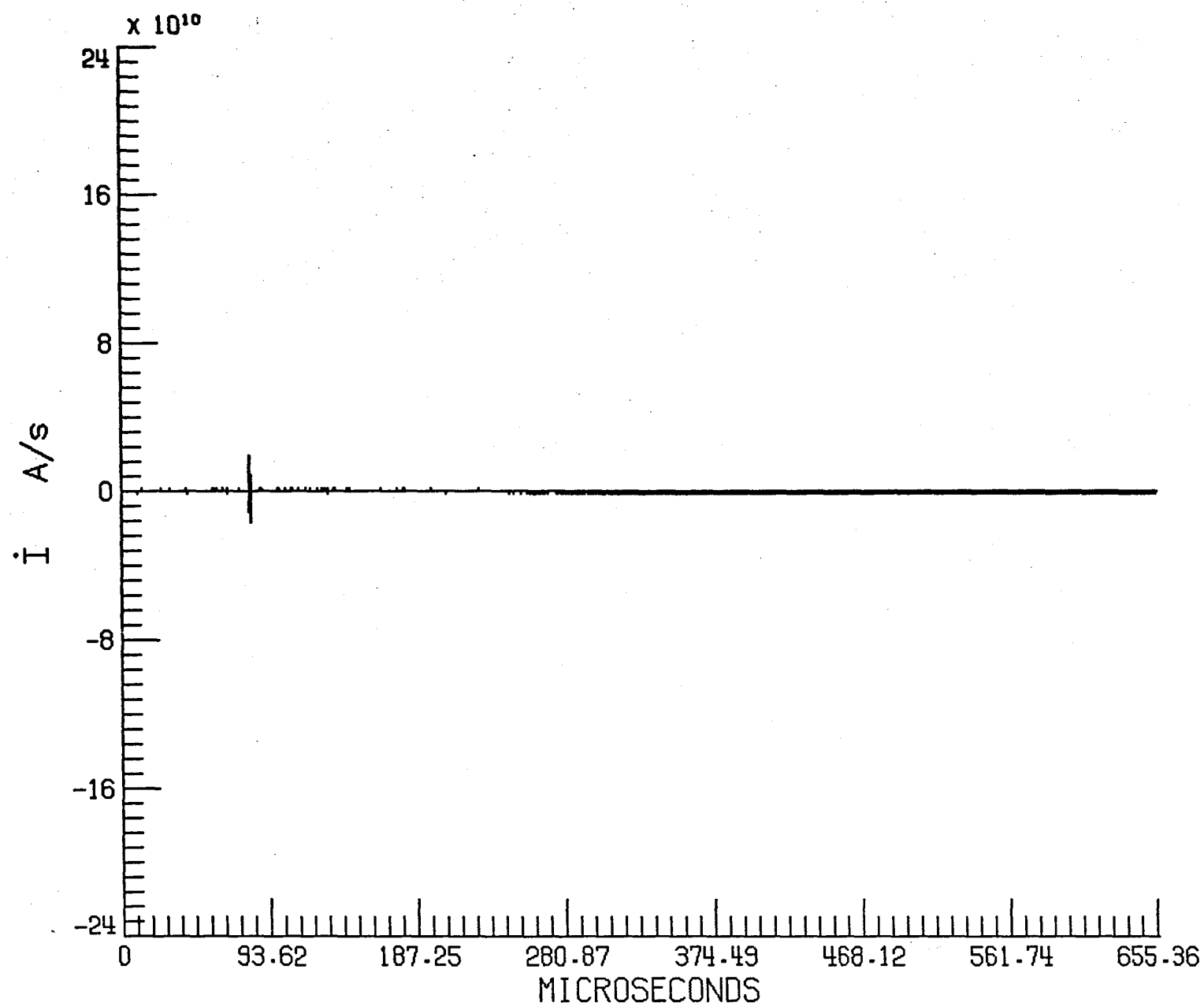
22:11:01.8428

CHANNEL NO. 3.2

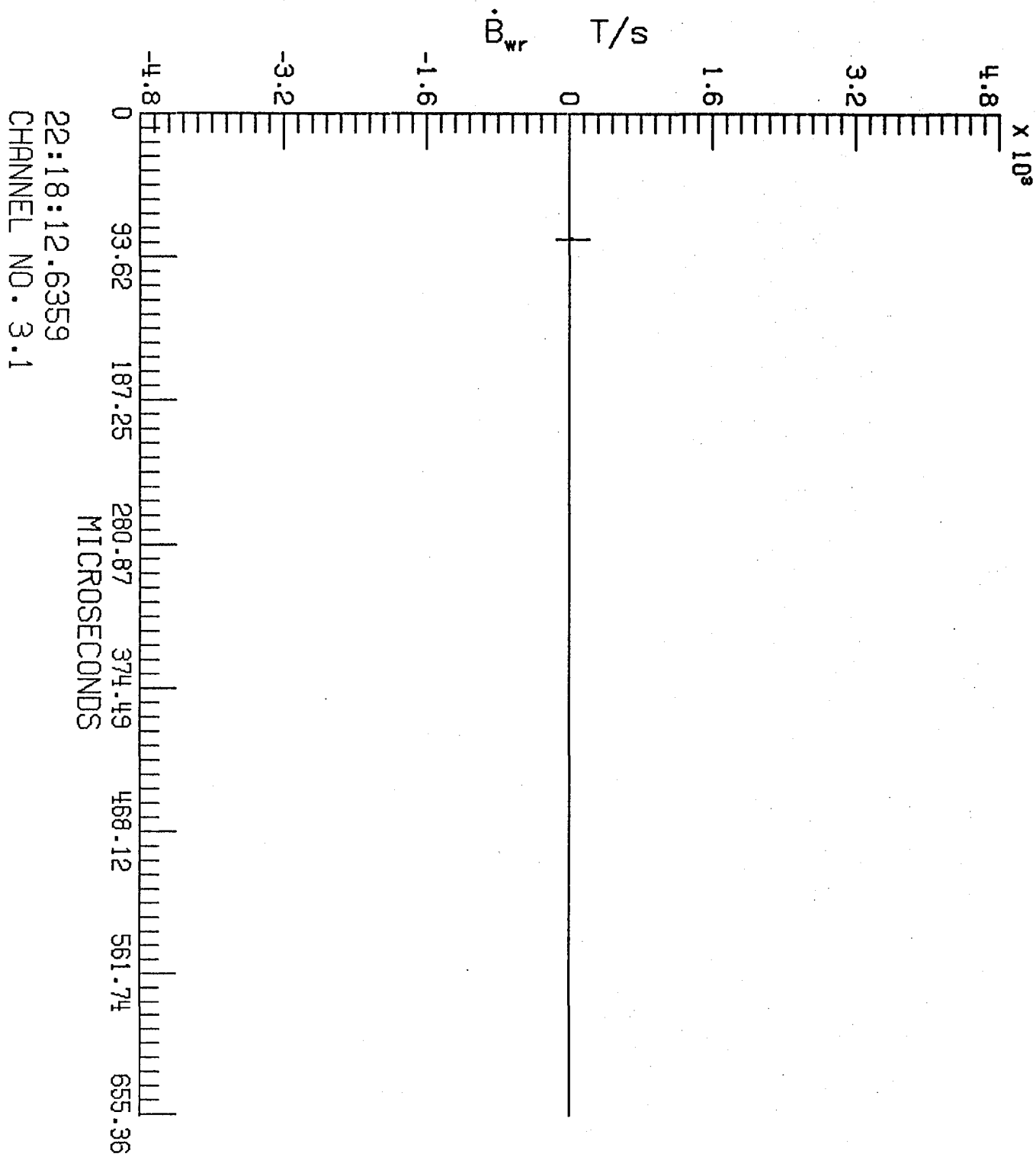


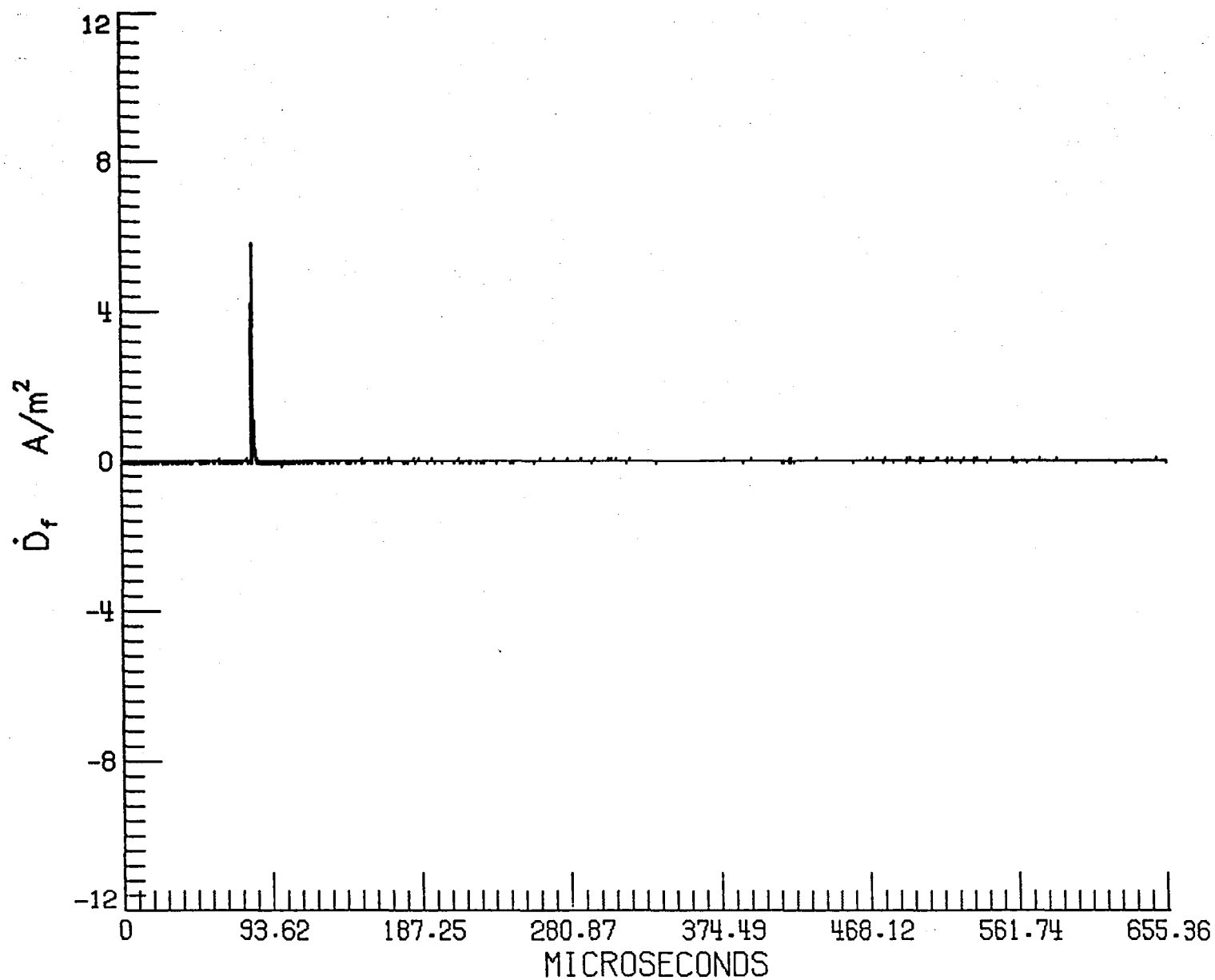
383

22:10:55.7559
CHANNEL NO. 4.1



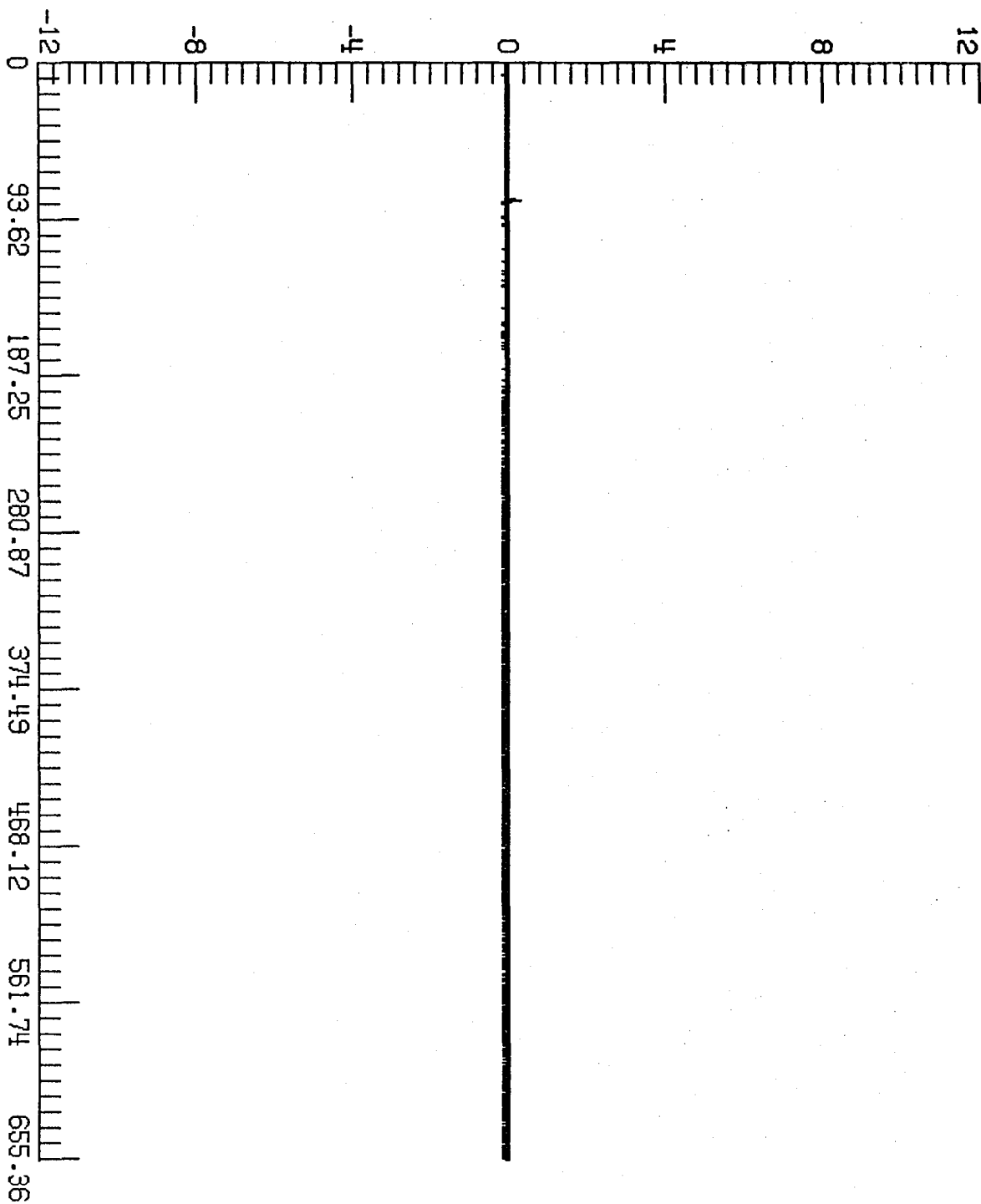
22:11:01.8519
CHANNEL NO. 4.2





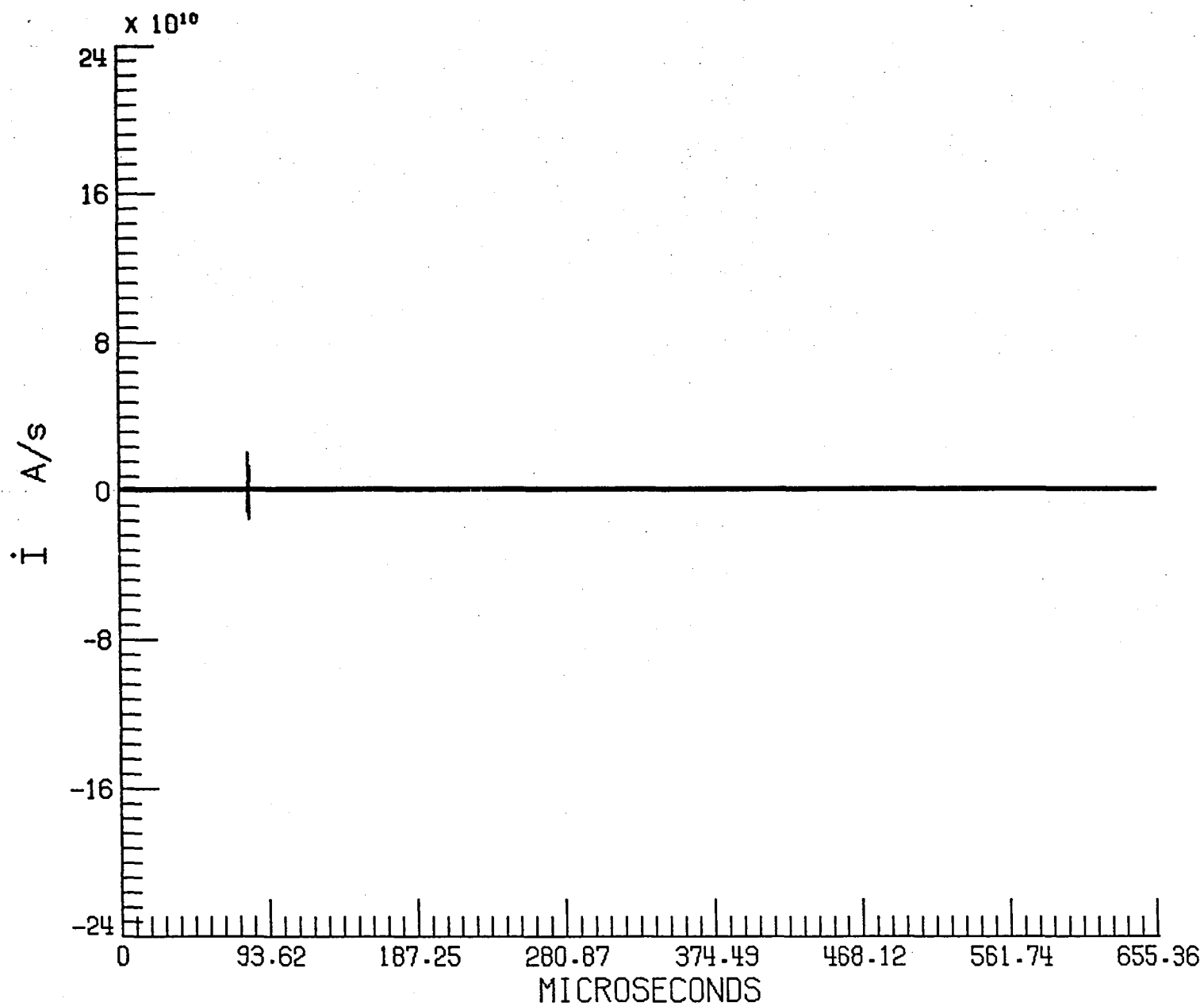
22:18:18.7320
CHANNEL NO. 3.2

\dot{D}_t A/m²

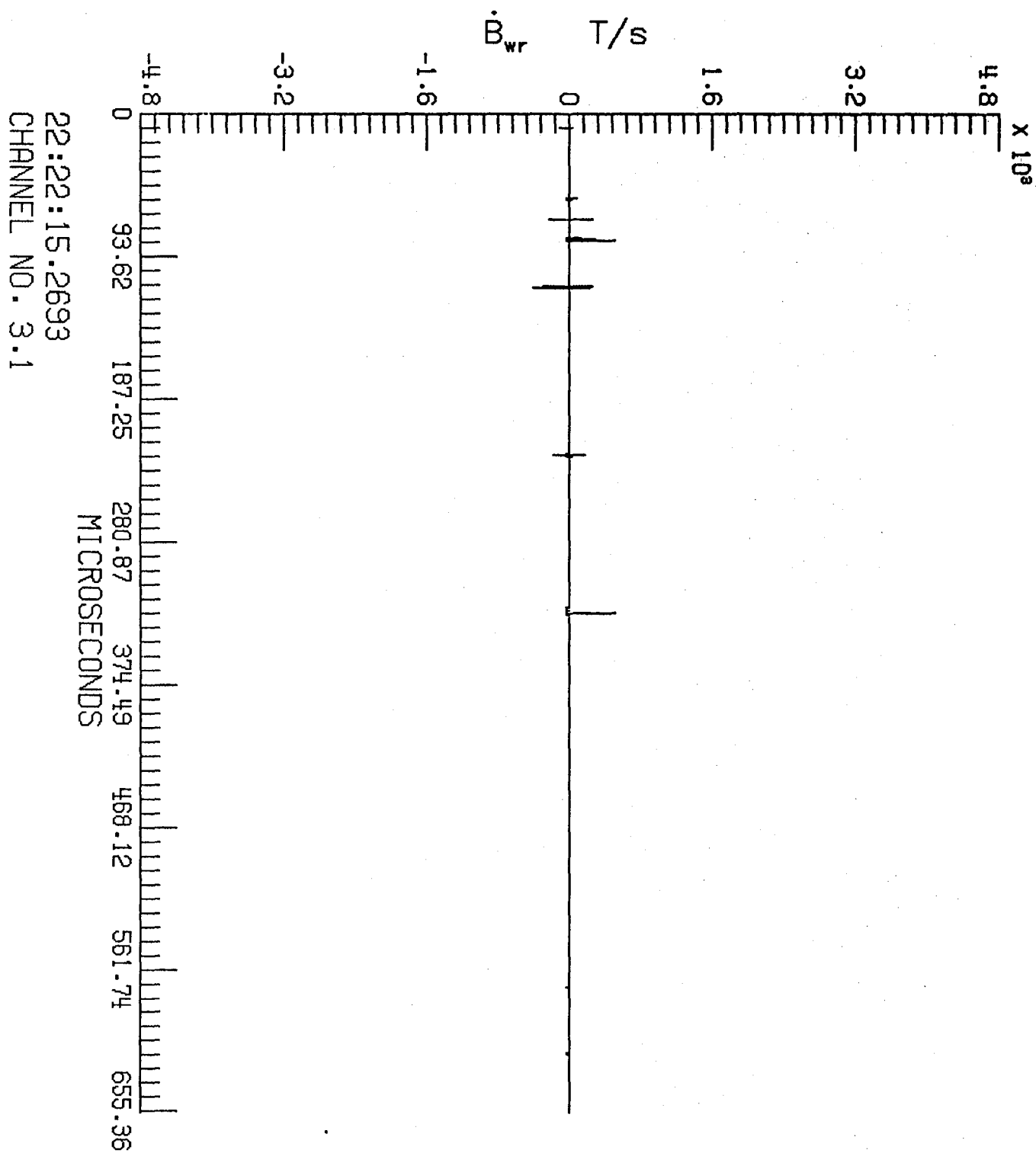


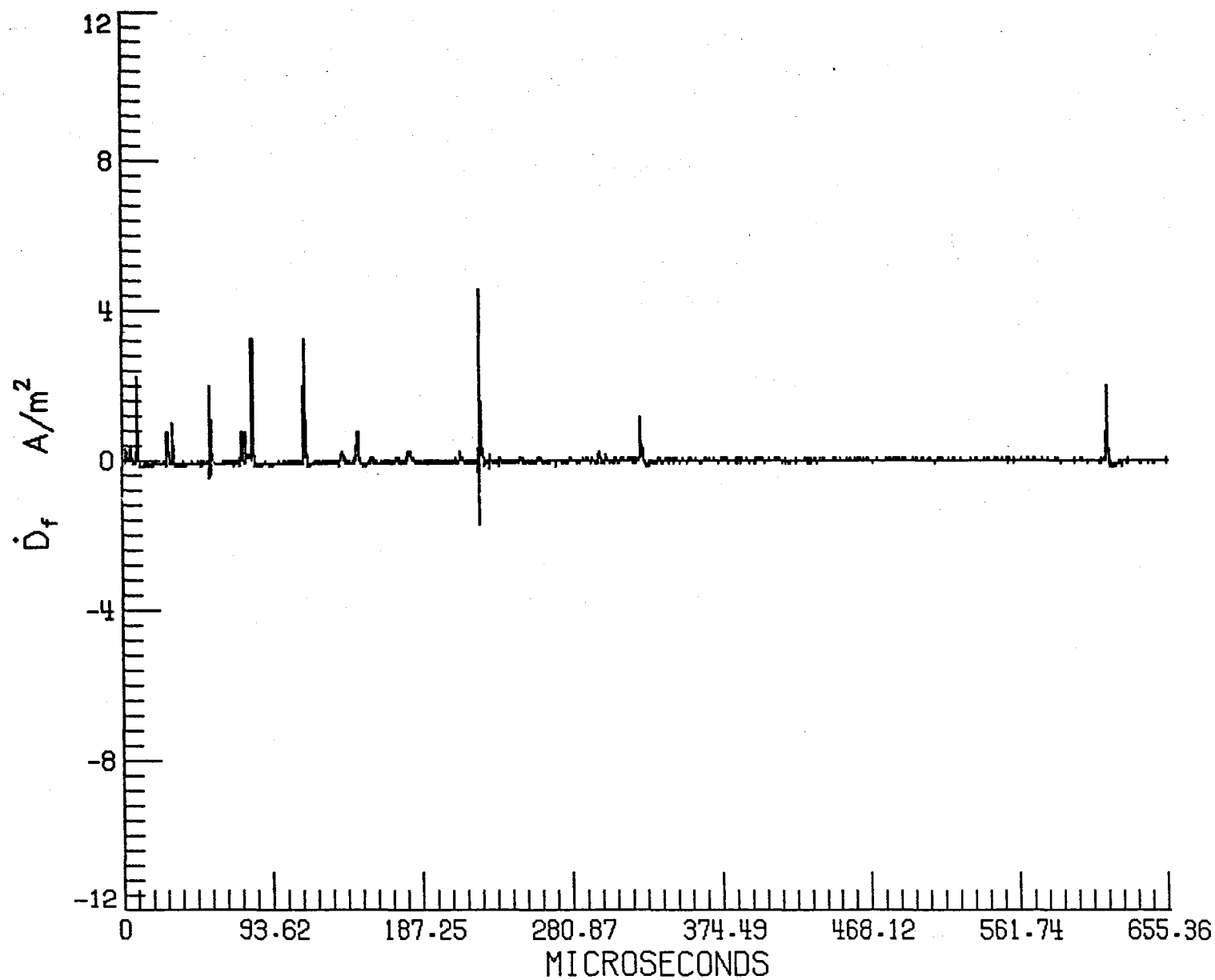
22:18:18.7116
CHANNEL NO. 4.1

MICROSECONDS



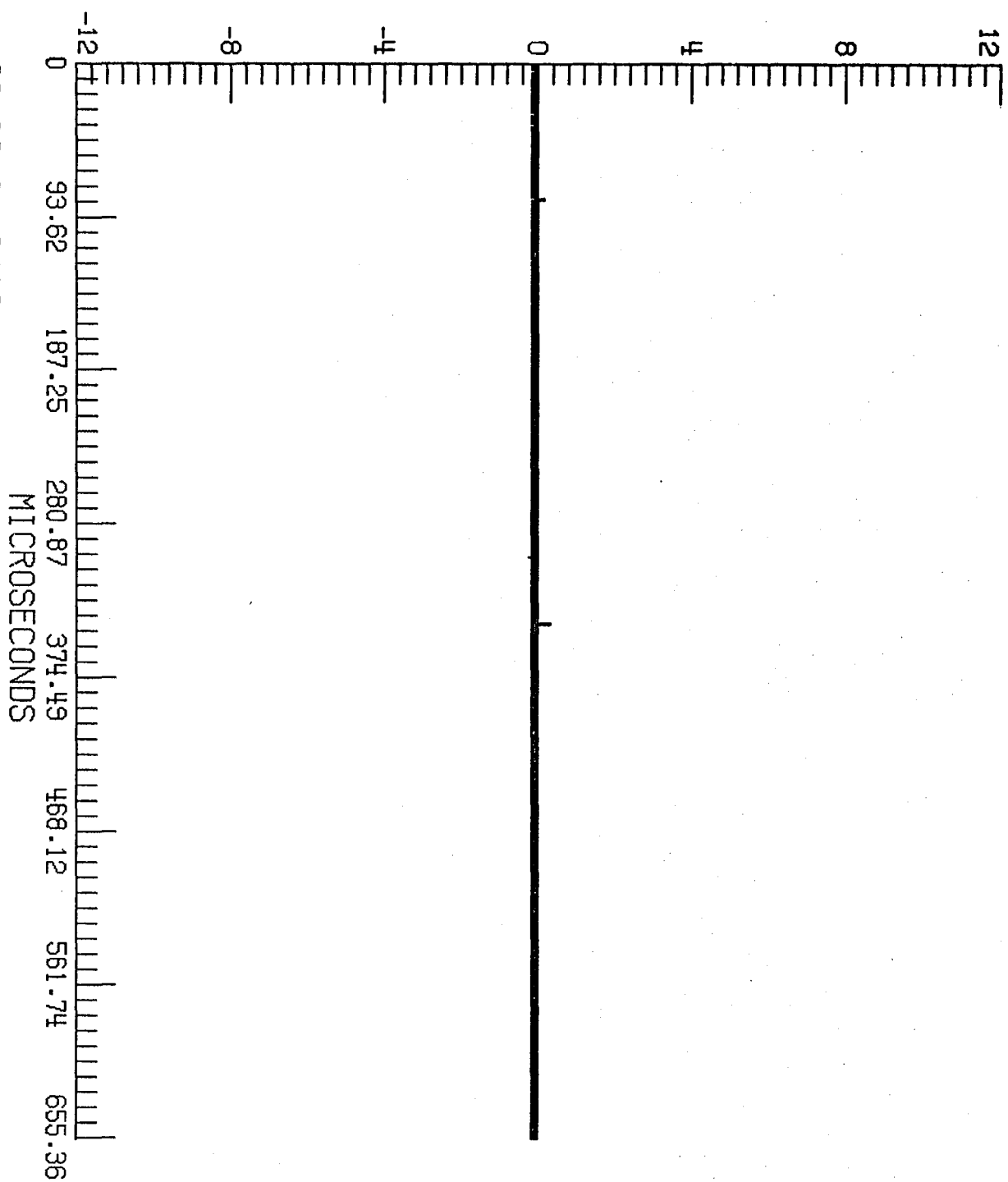
22:18:24.8076
CHANNEL NO. 4.2



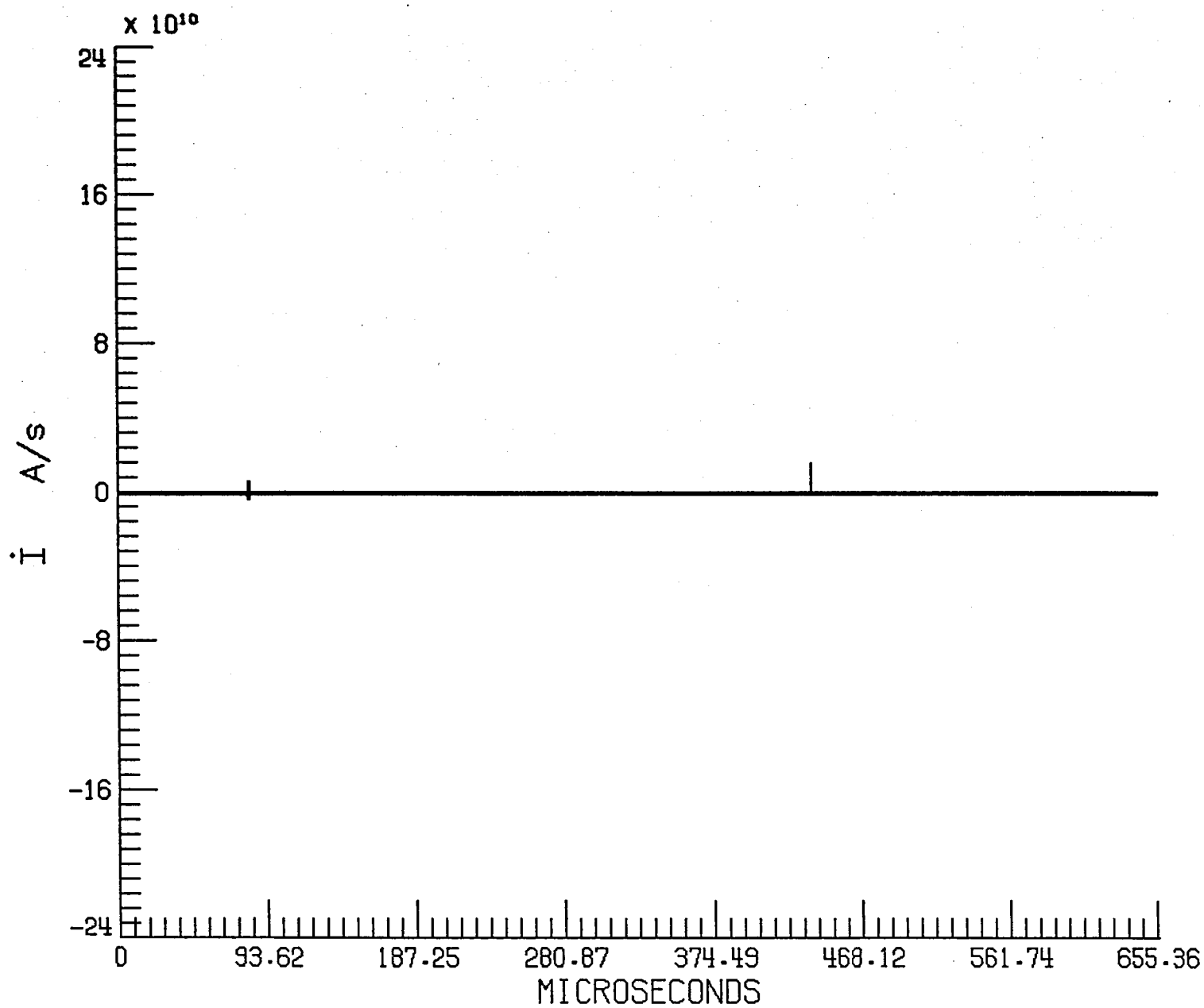


22:22:21.3653
CHANNEL NO. 3.2

$\dot{D}_t \quad A/m^2$

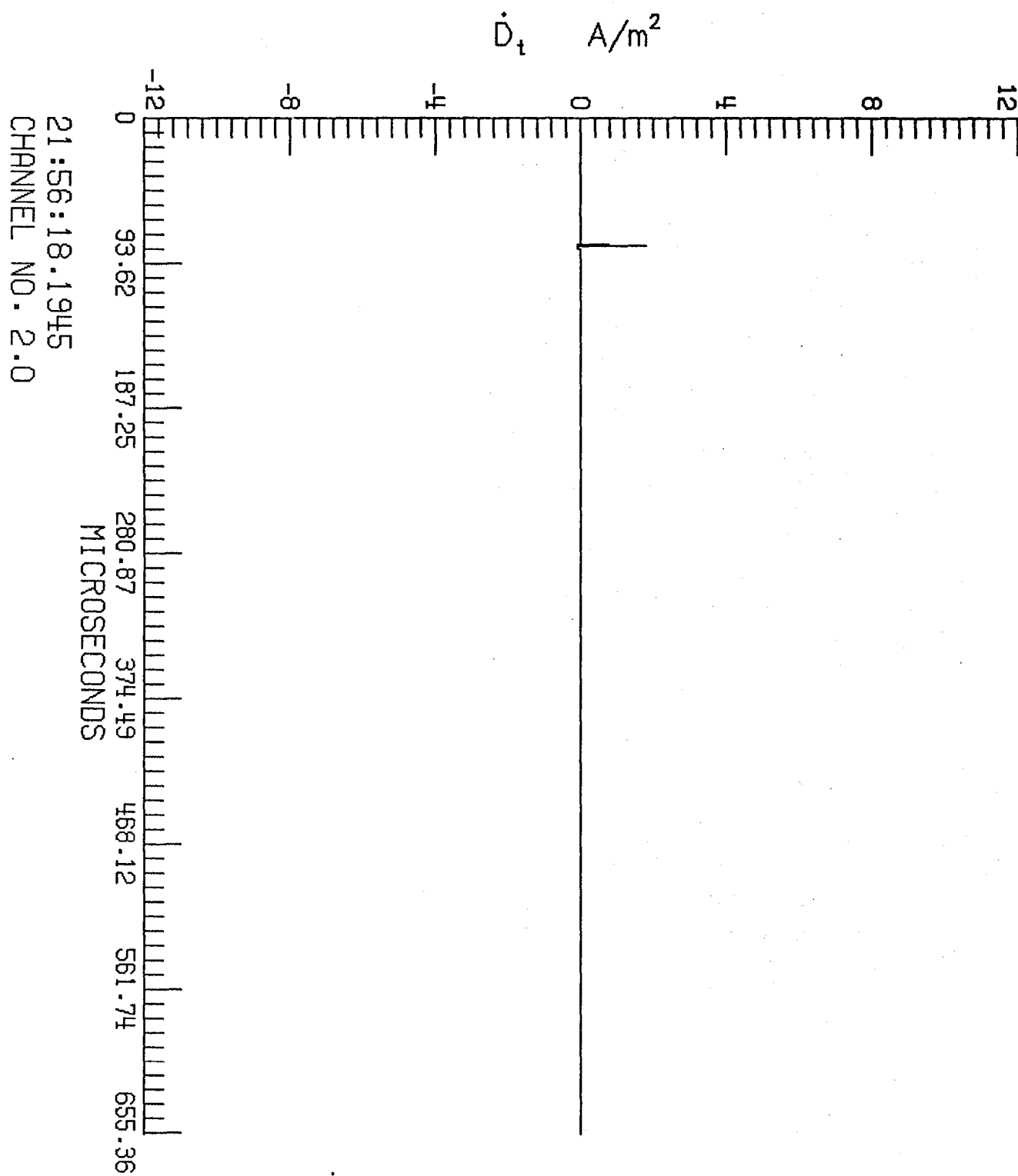


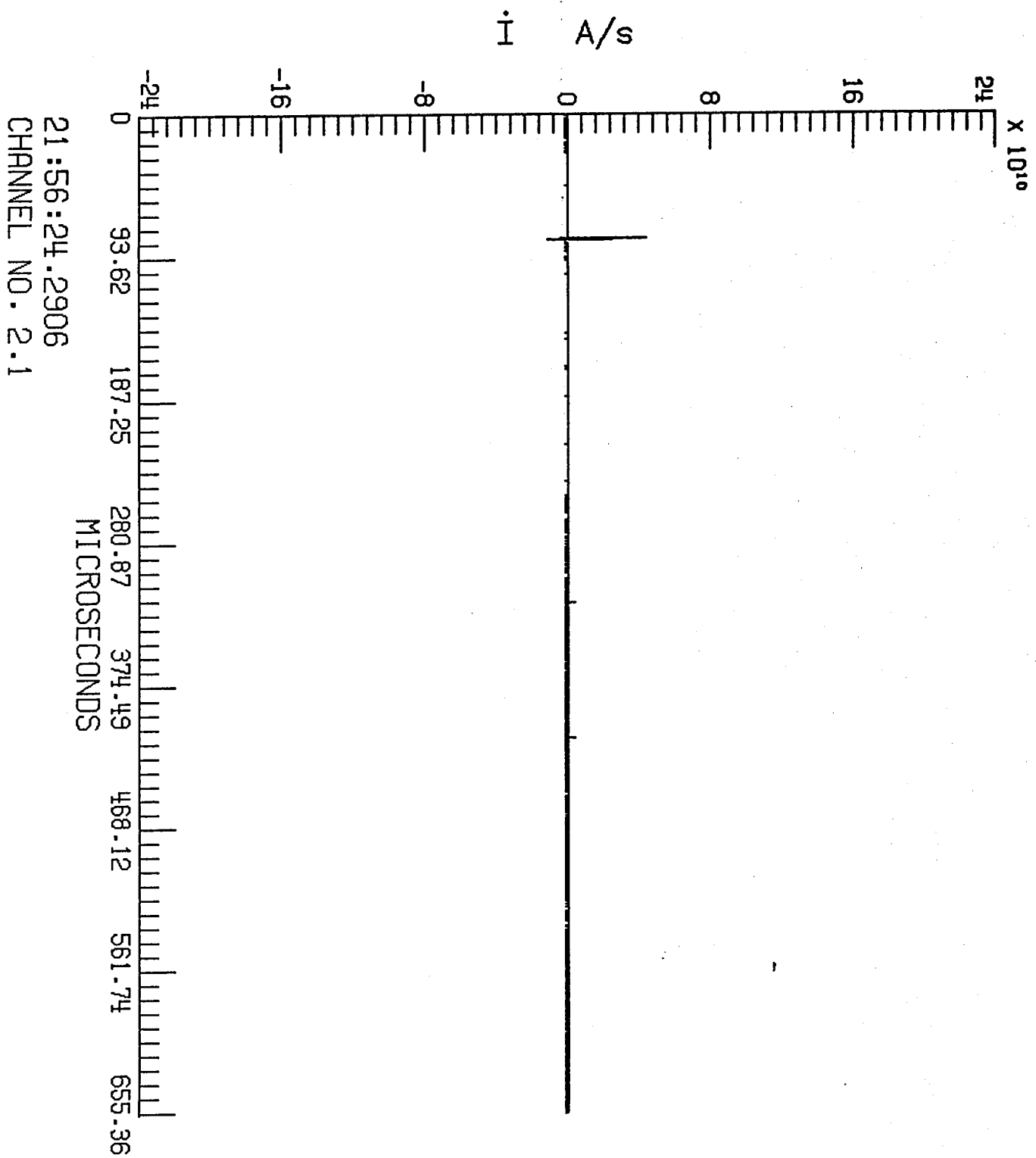
22:22:21.3416
CHANNEL NO. 4.1

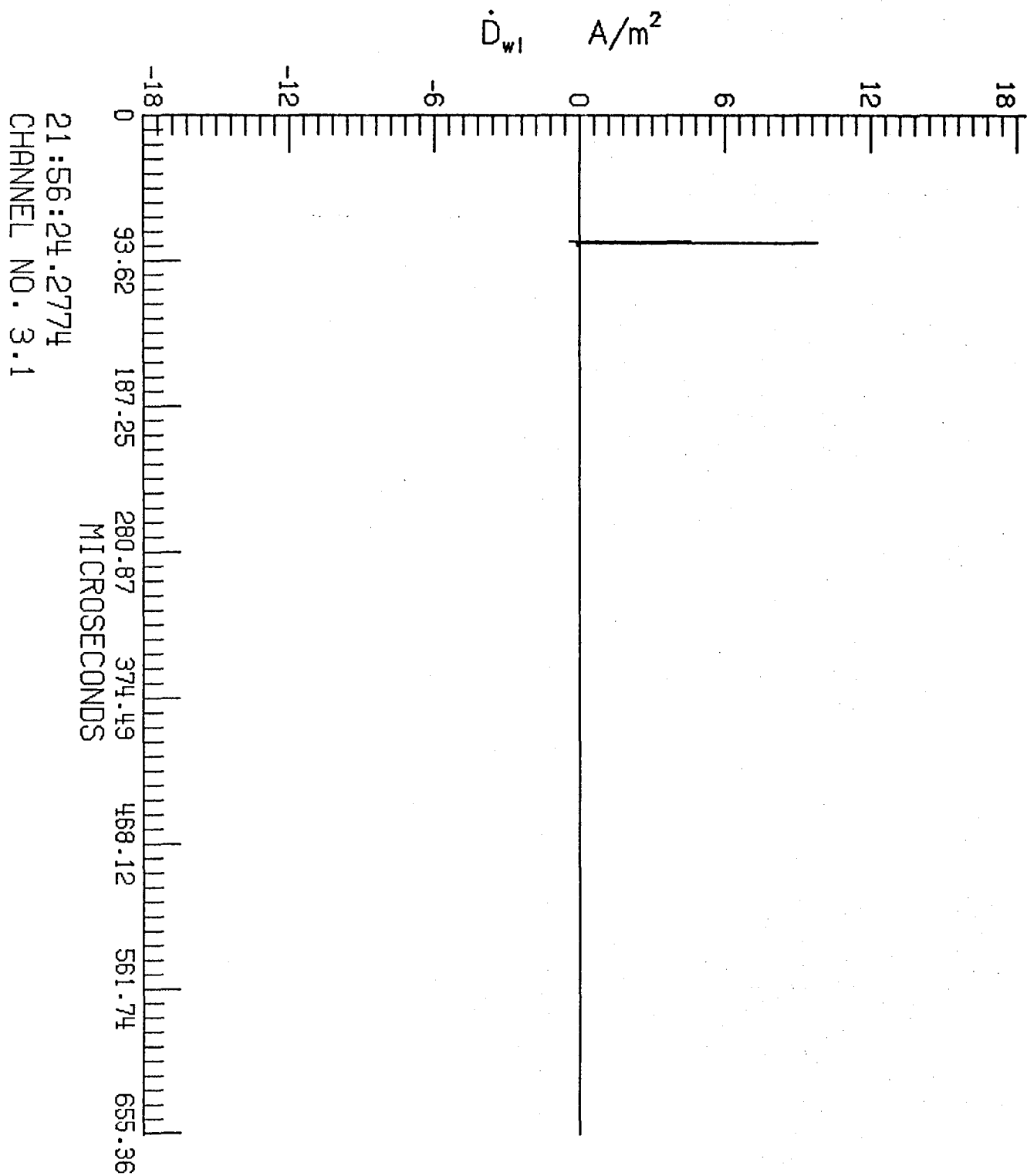


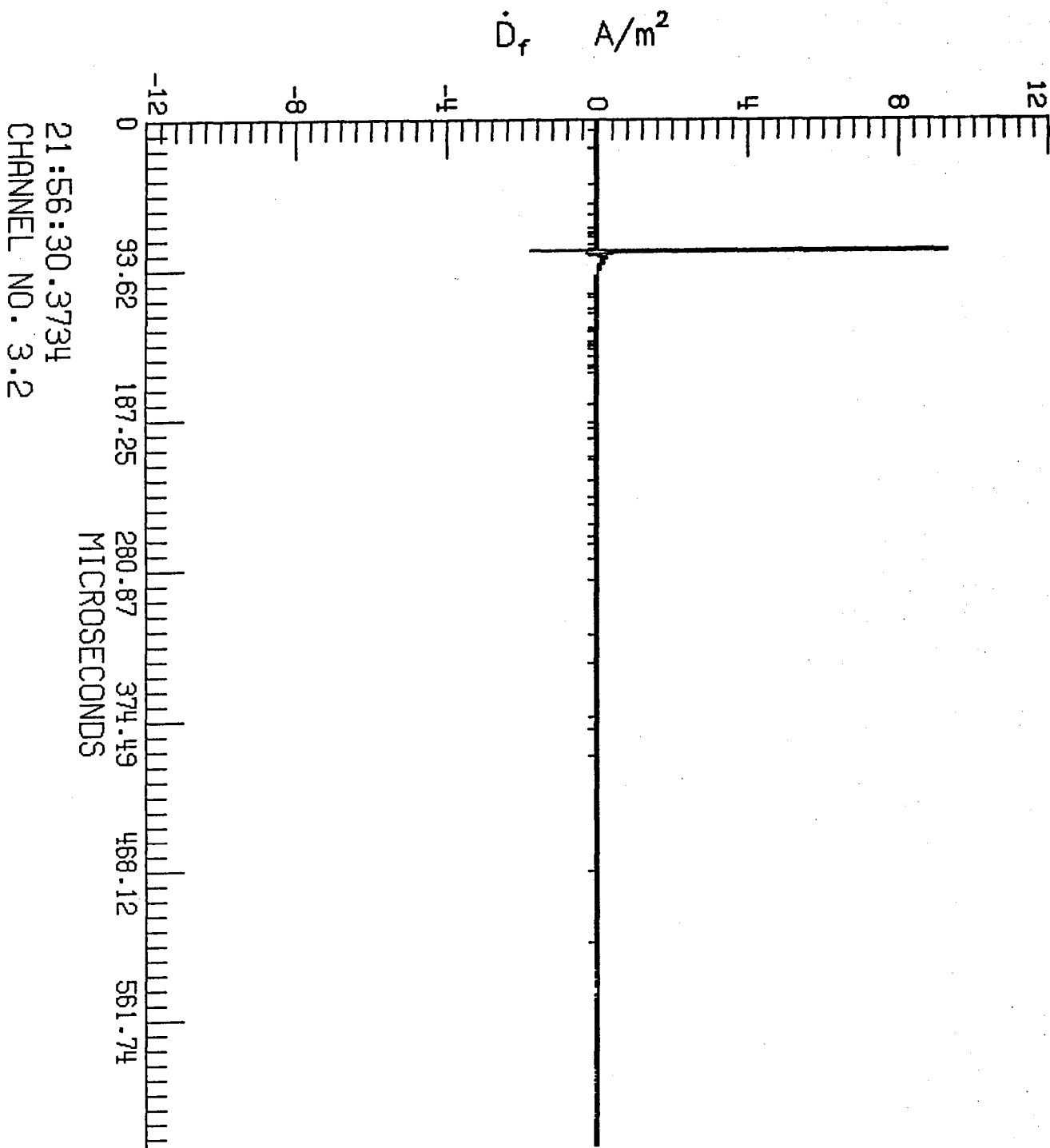
22:22:27.4376

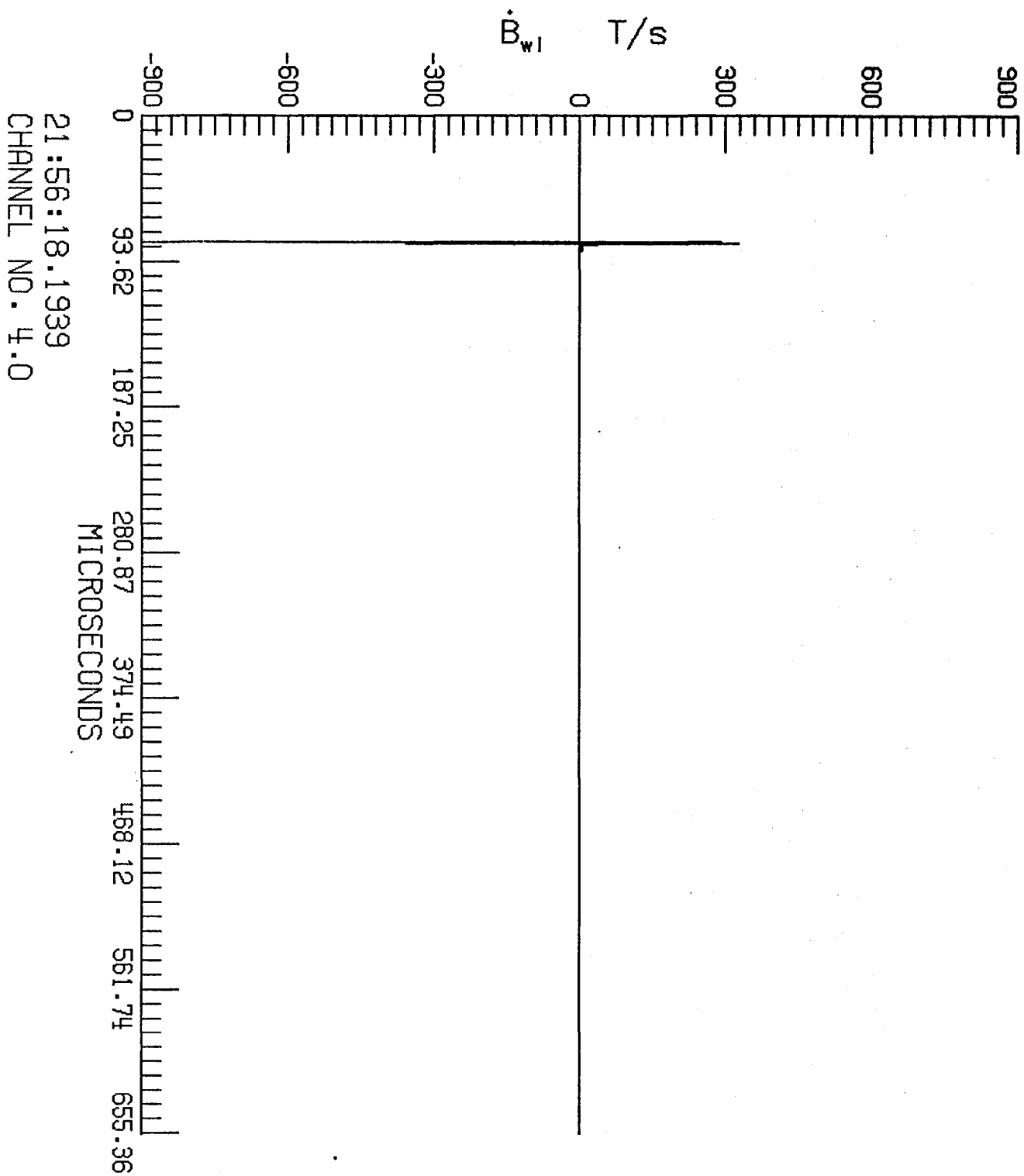
CHANNEL NO. 4.2

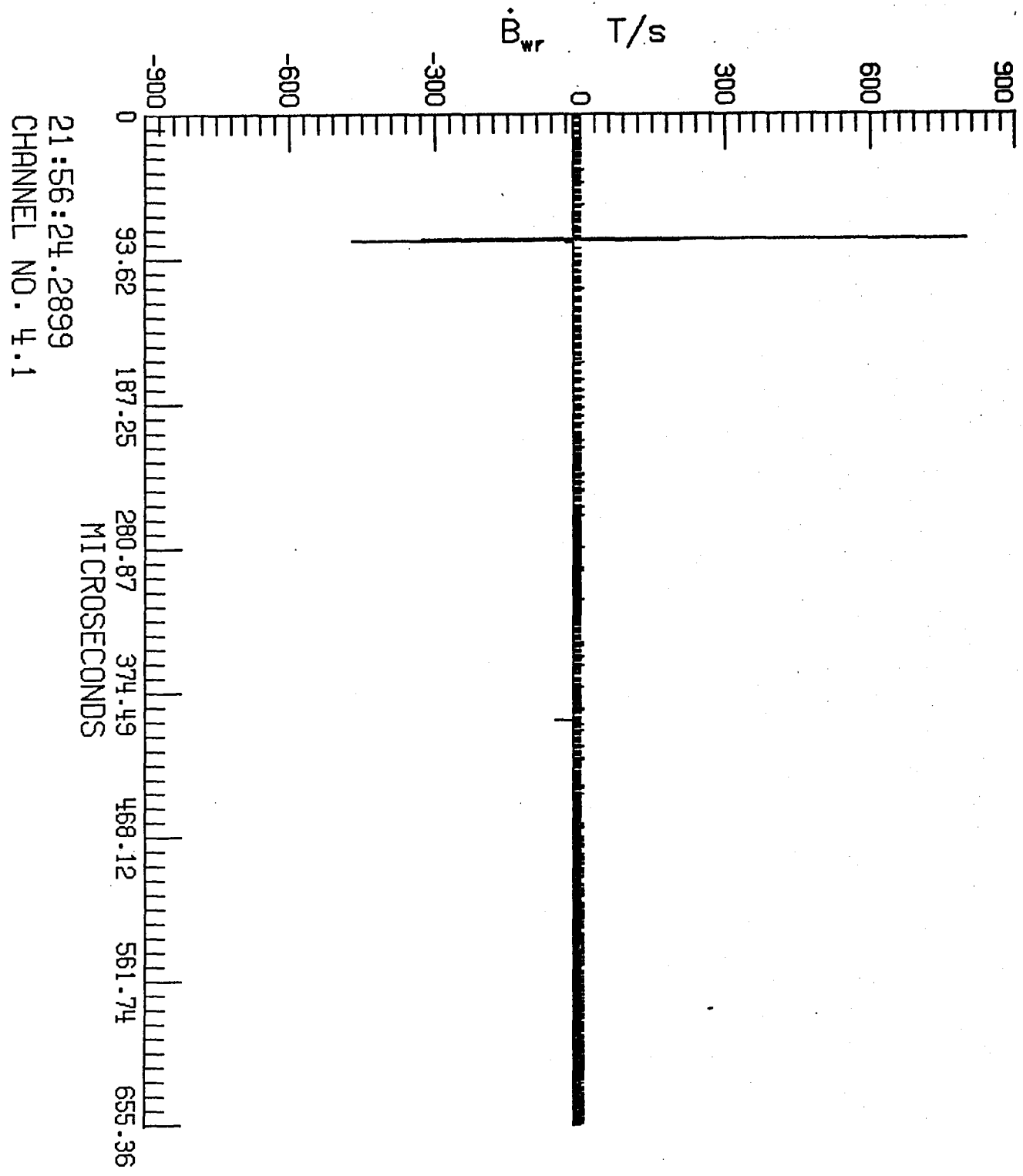


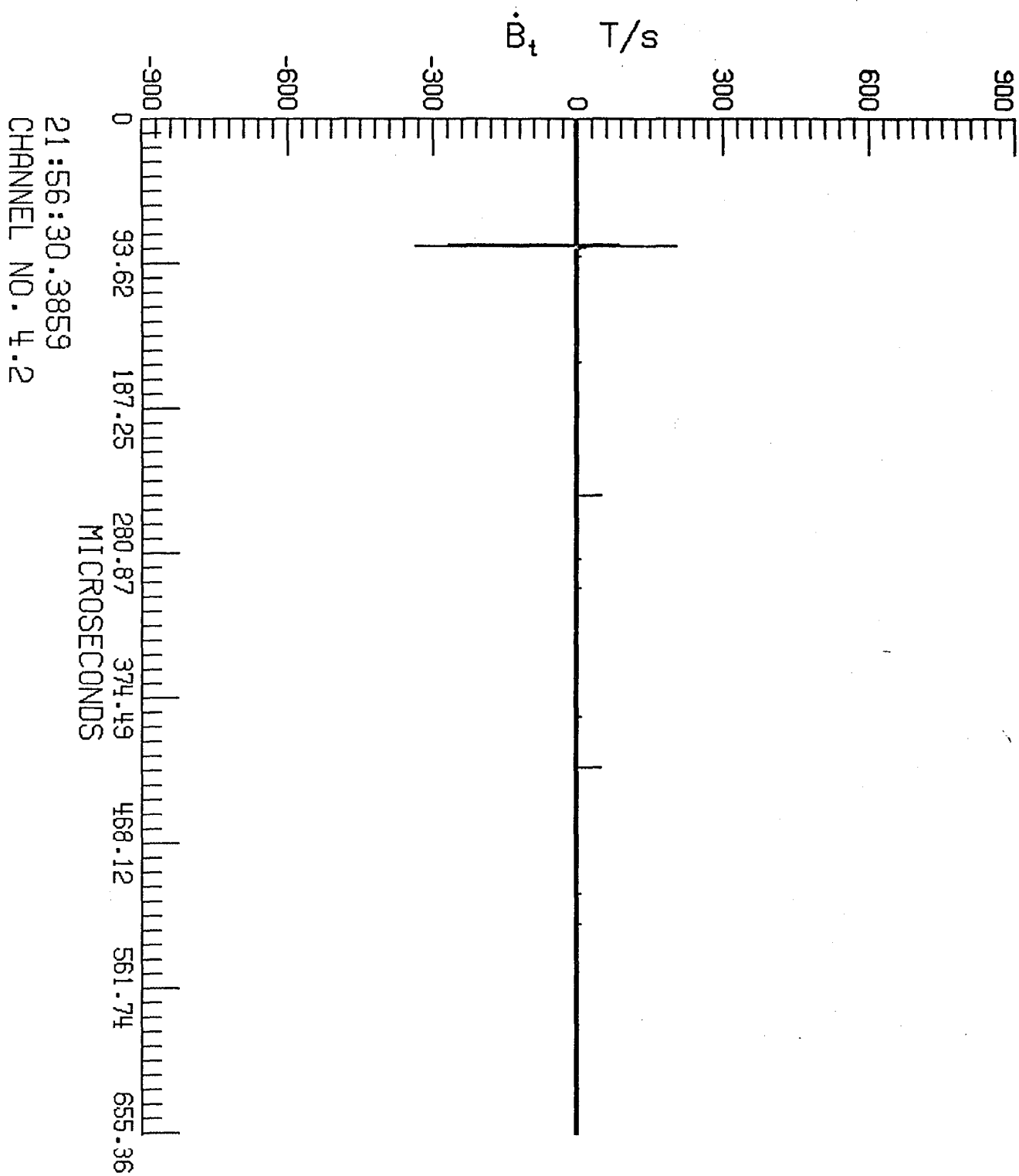


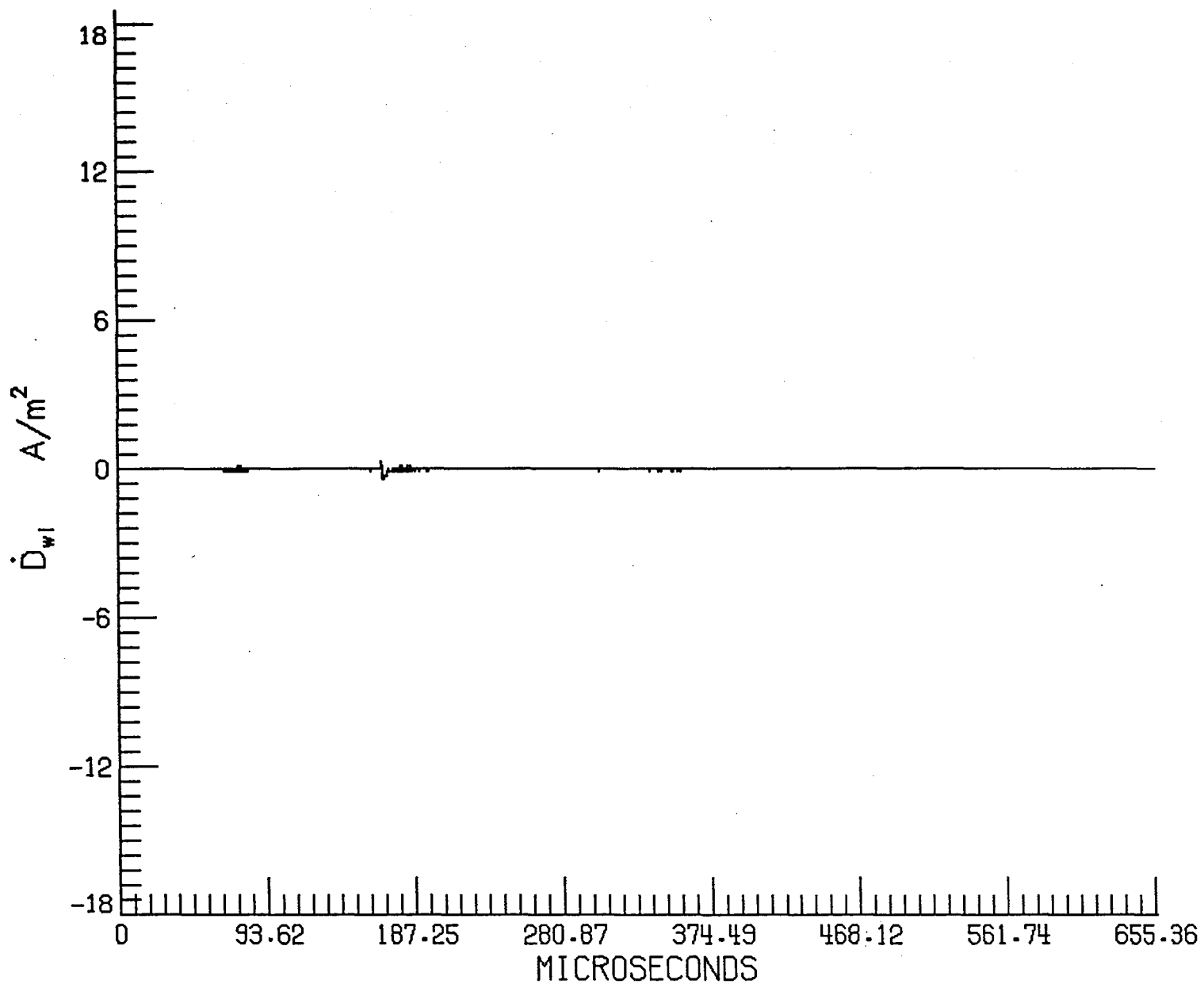




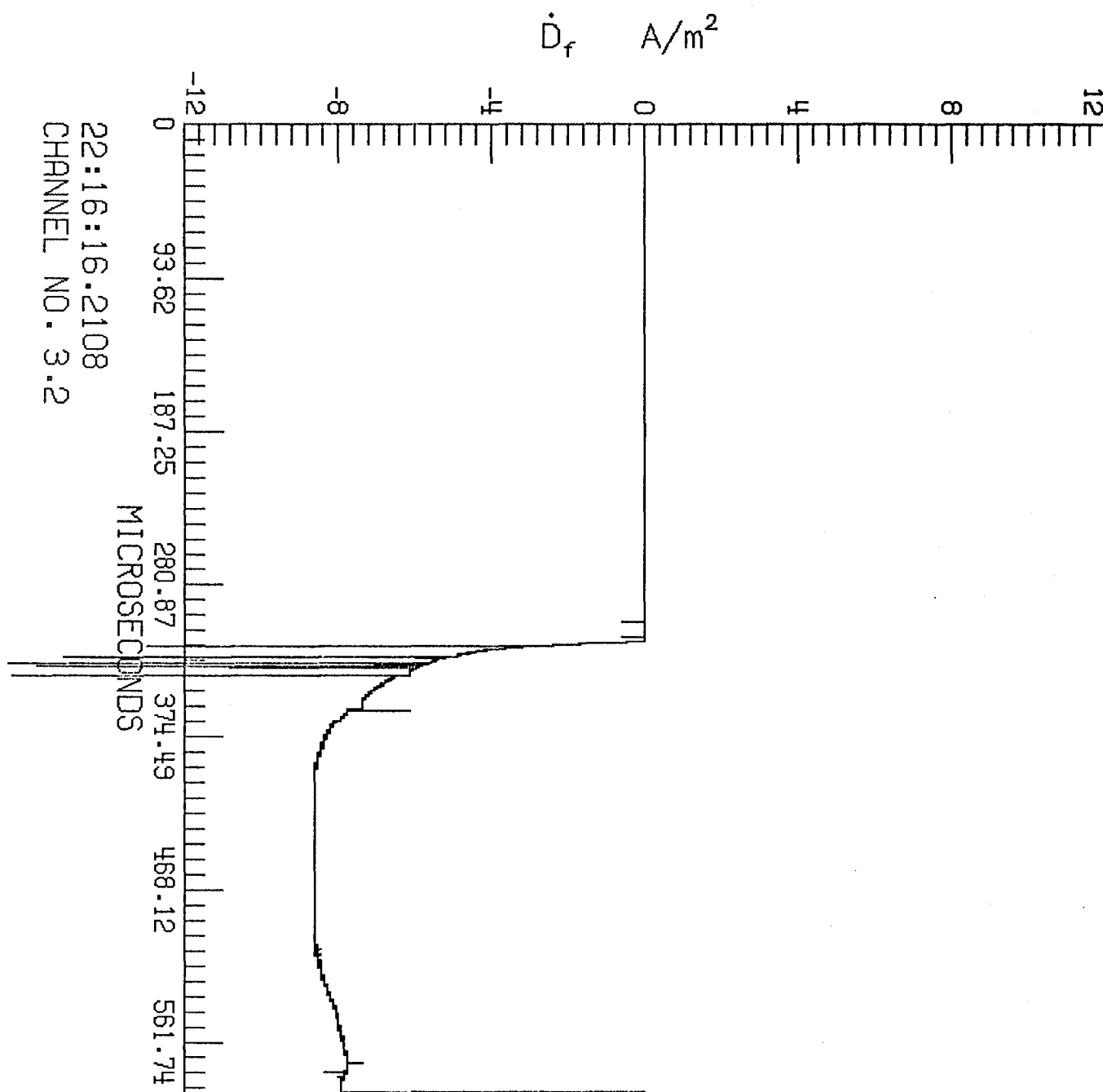


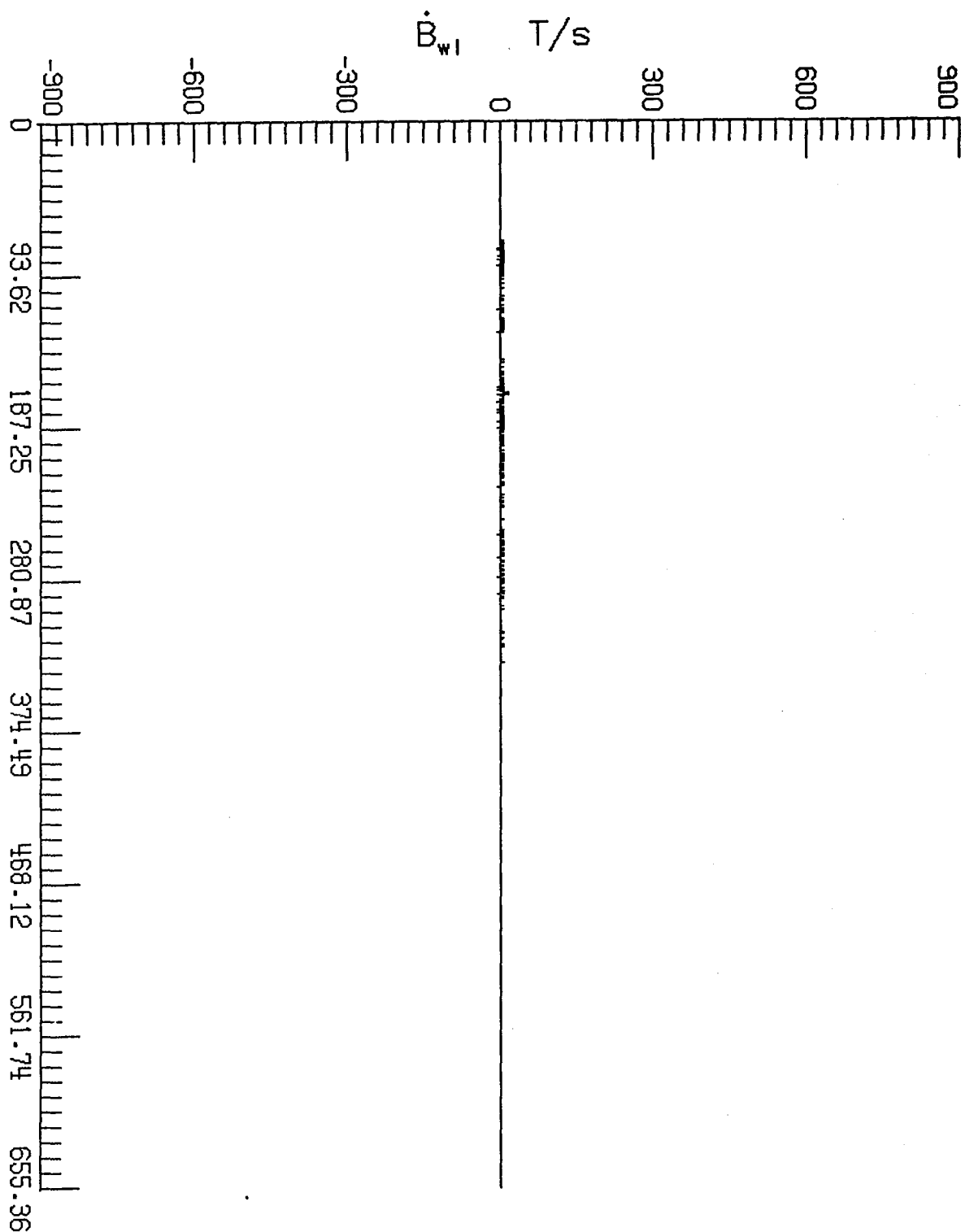




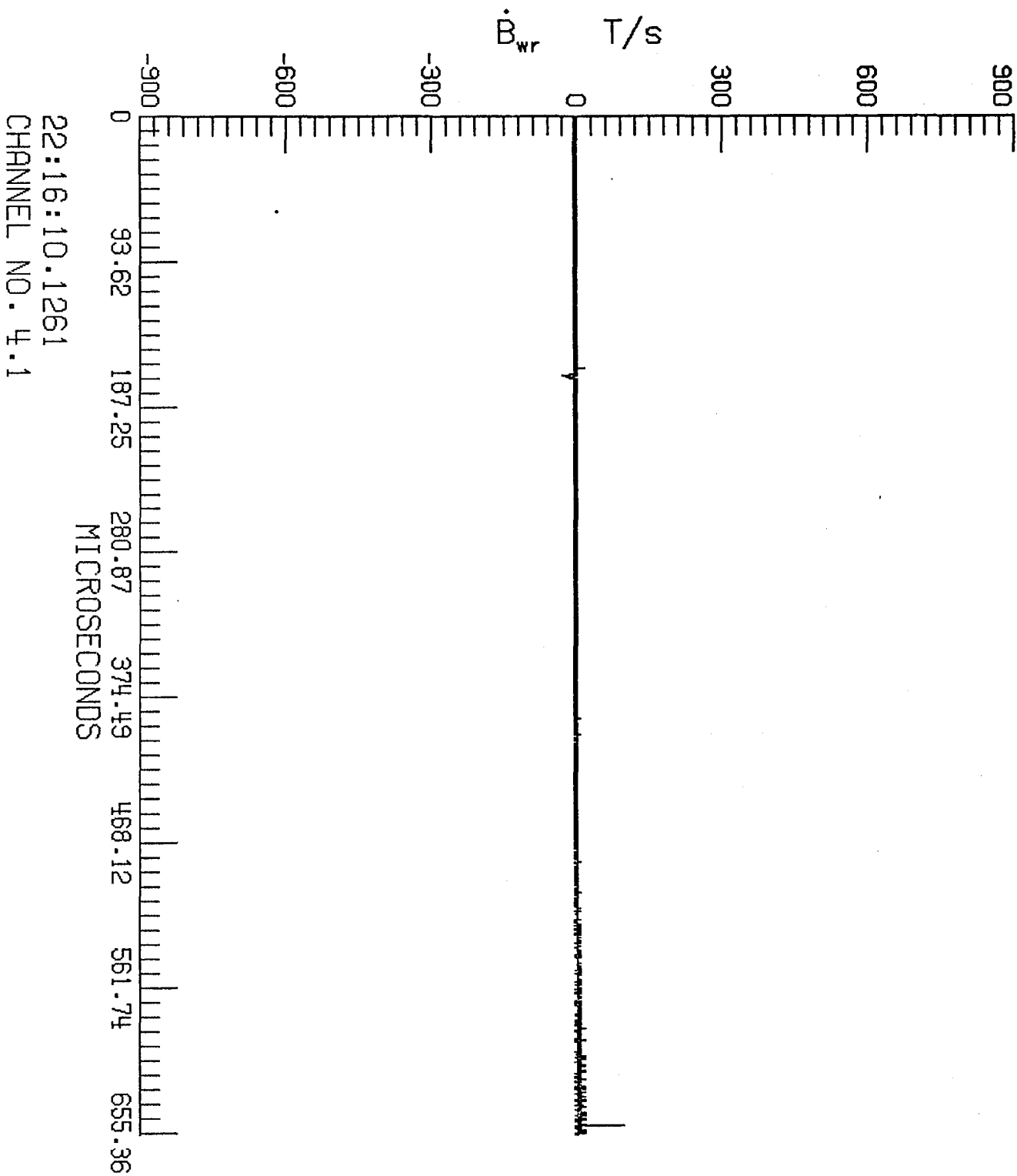


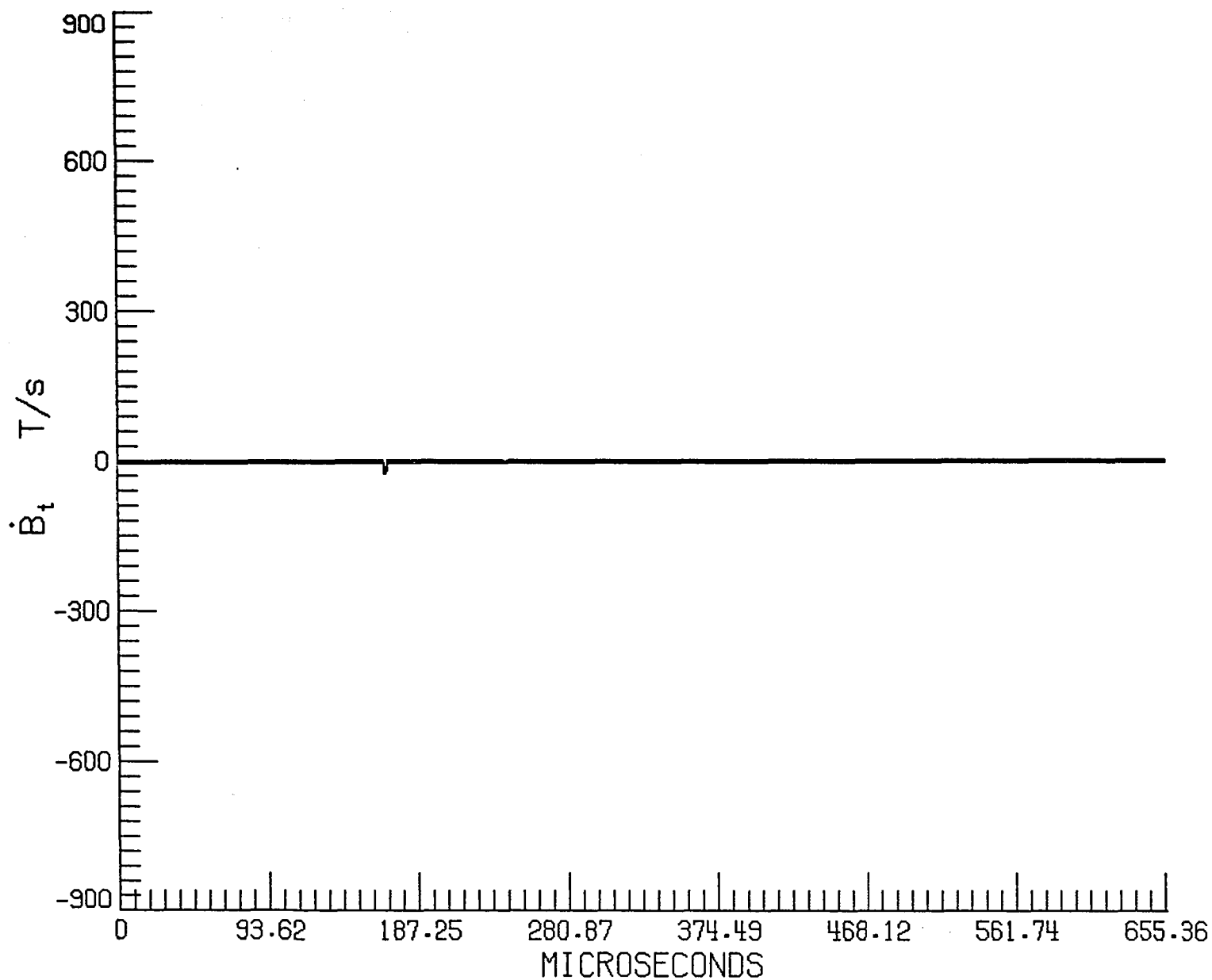
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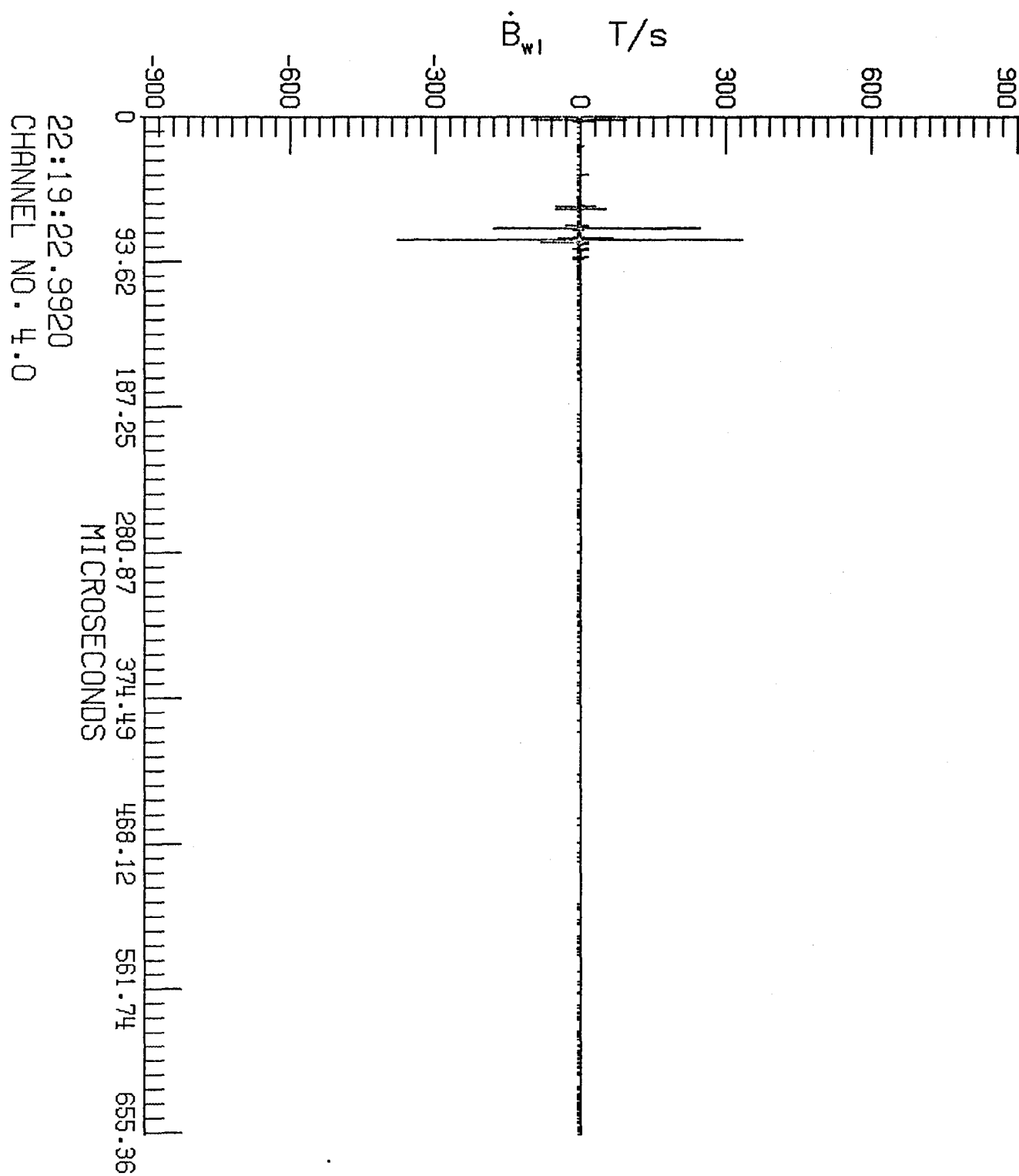


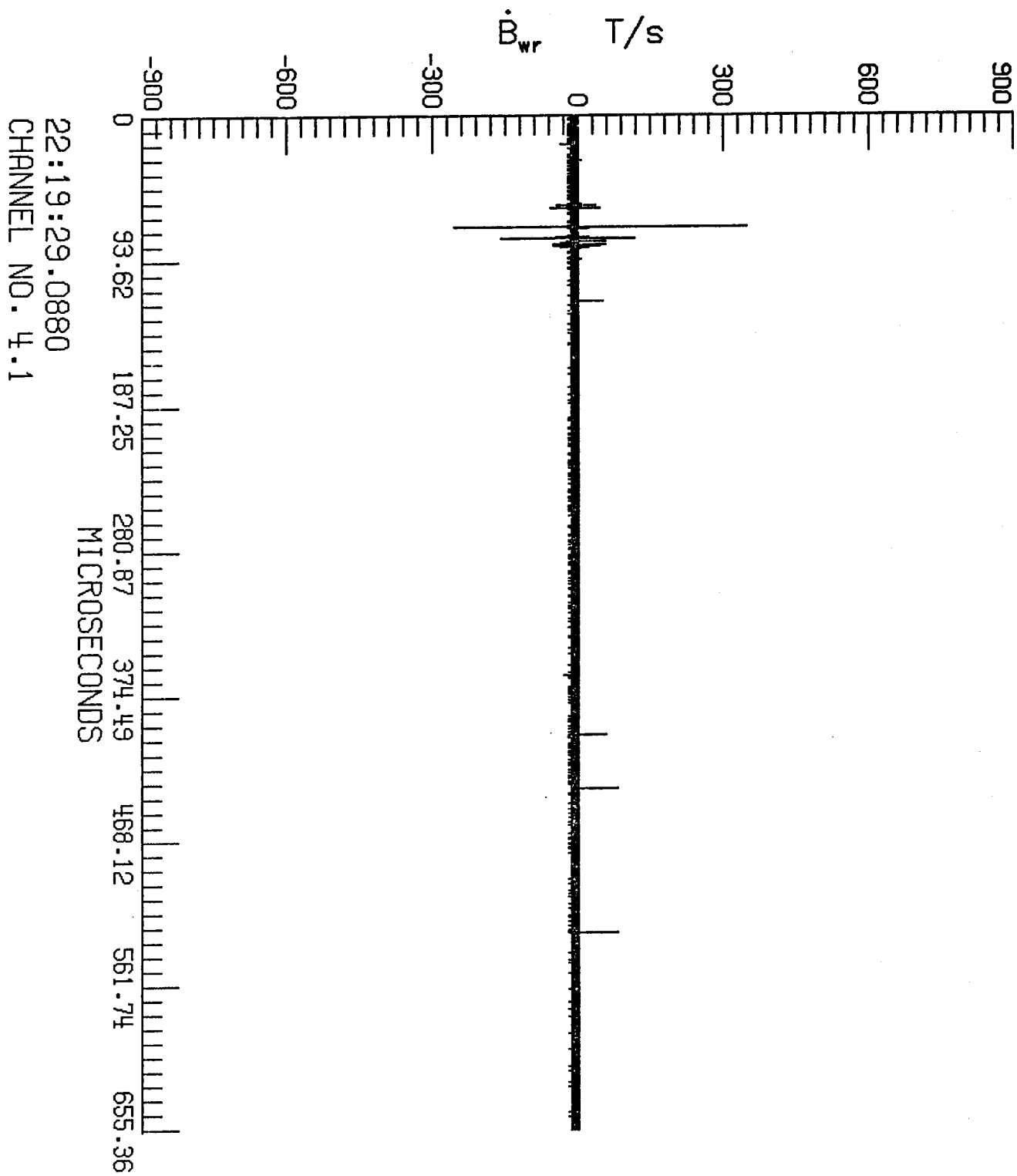
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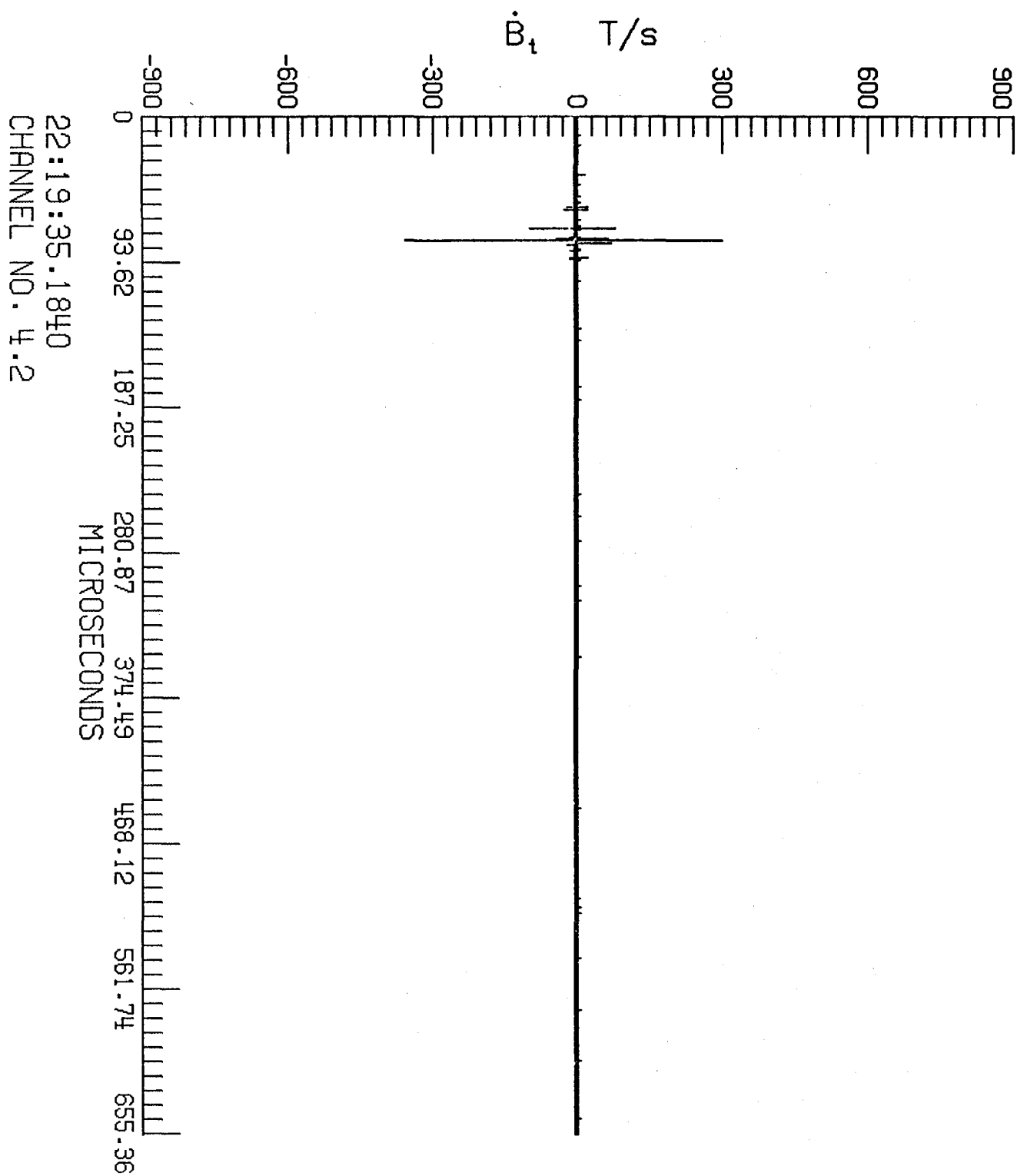


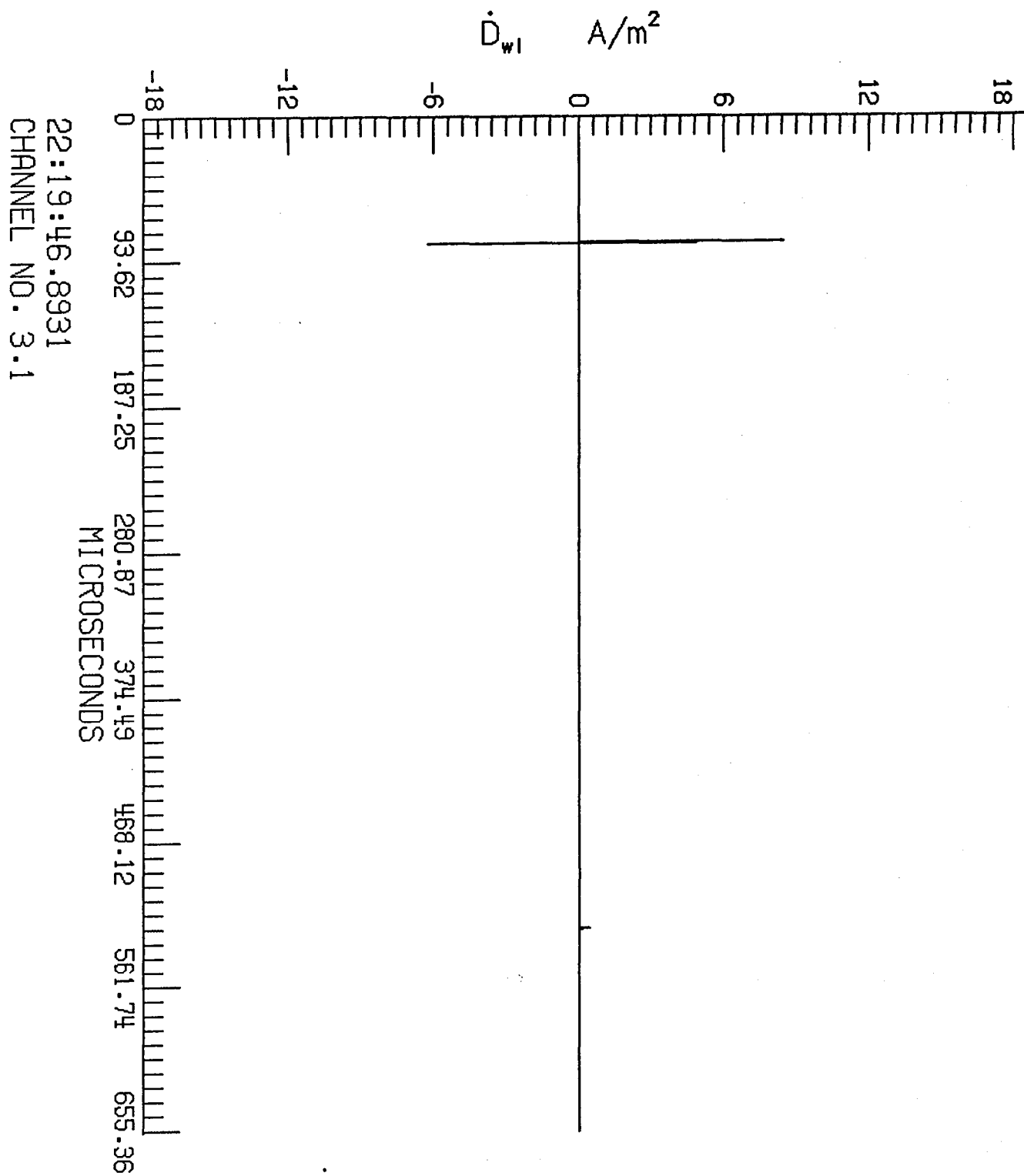


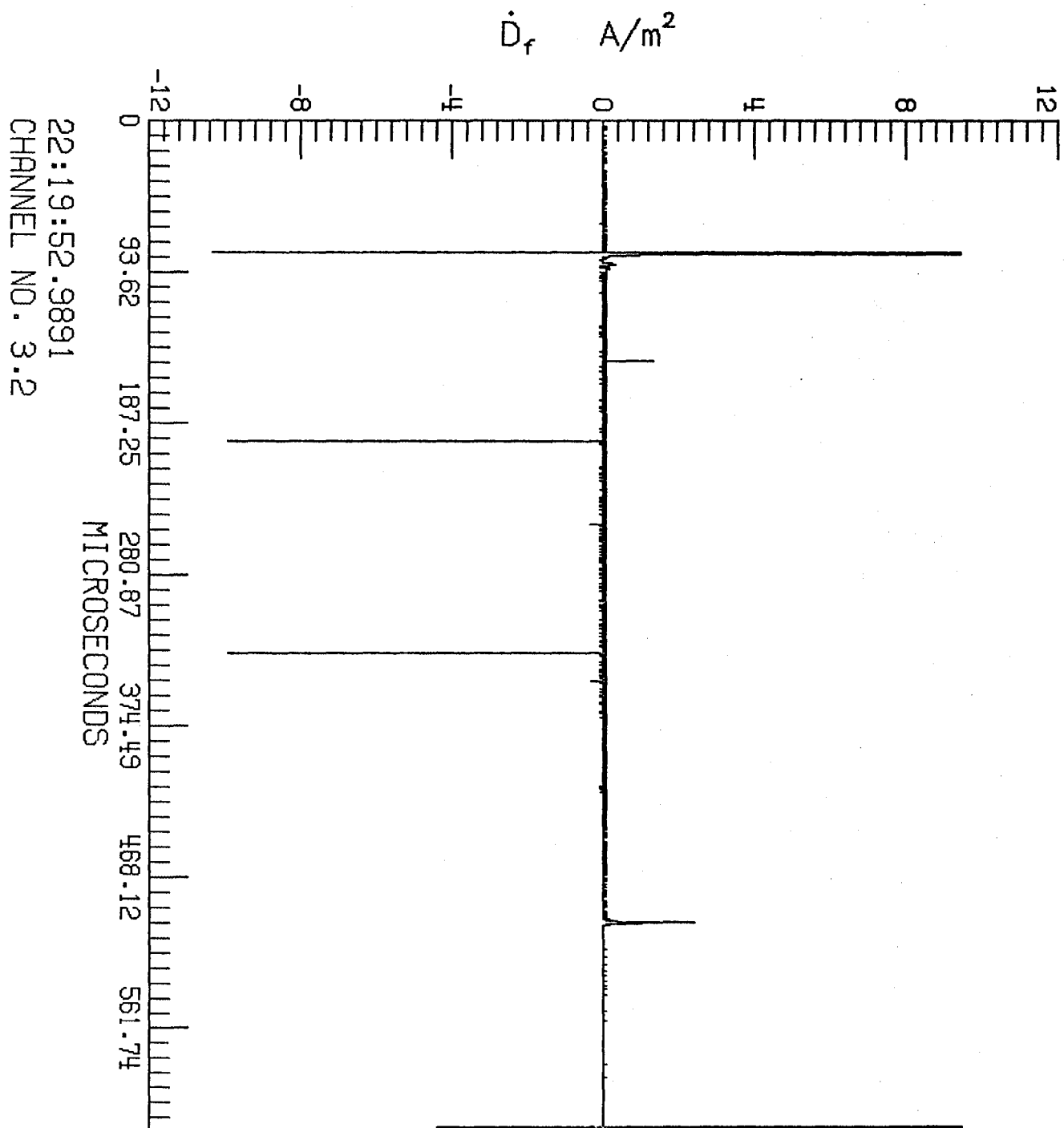
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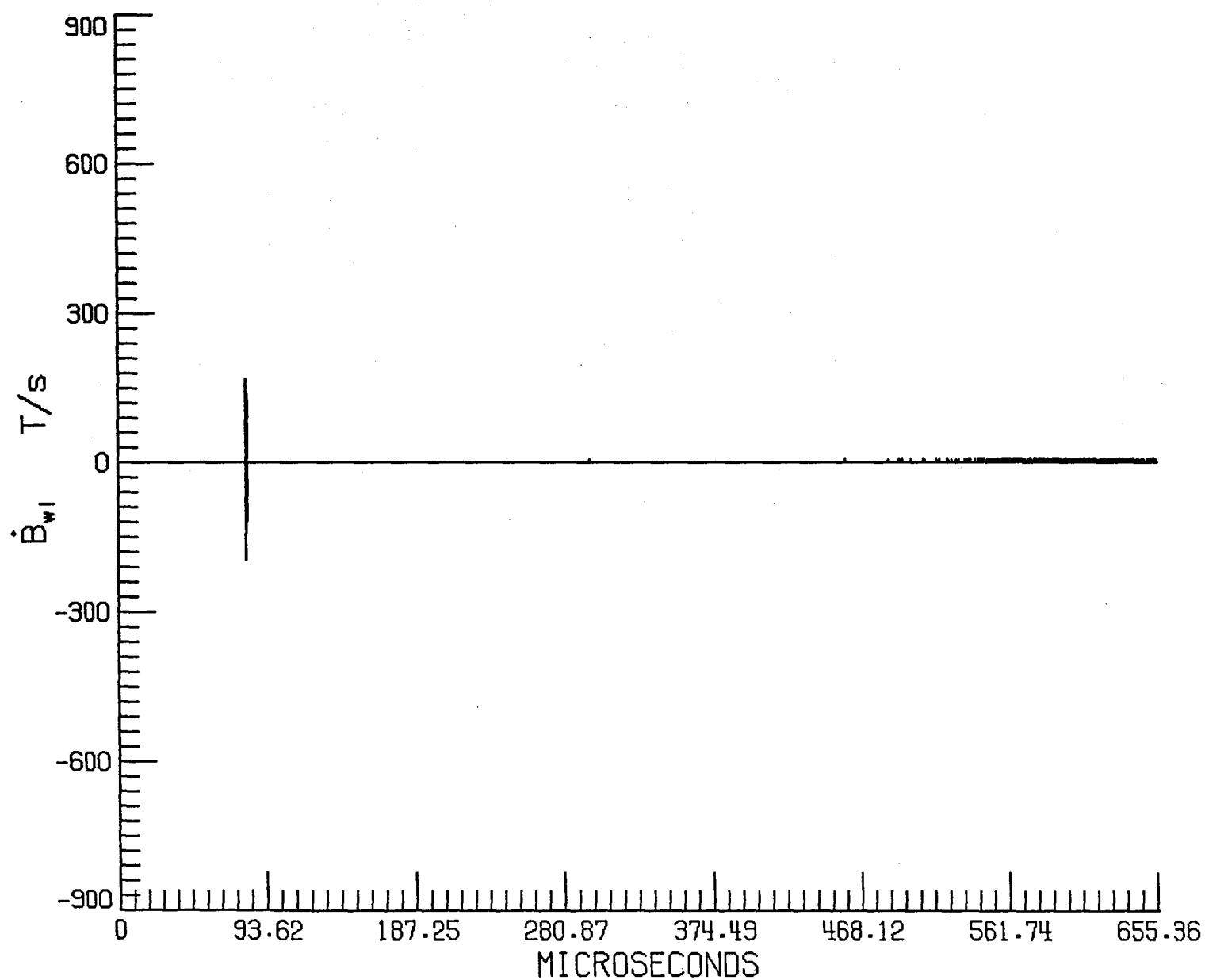






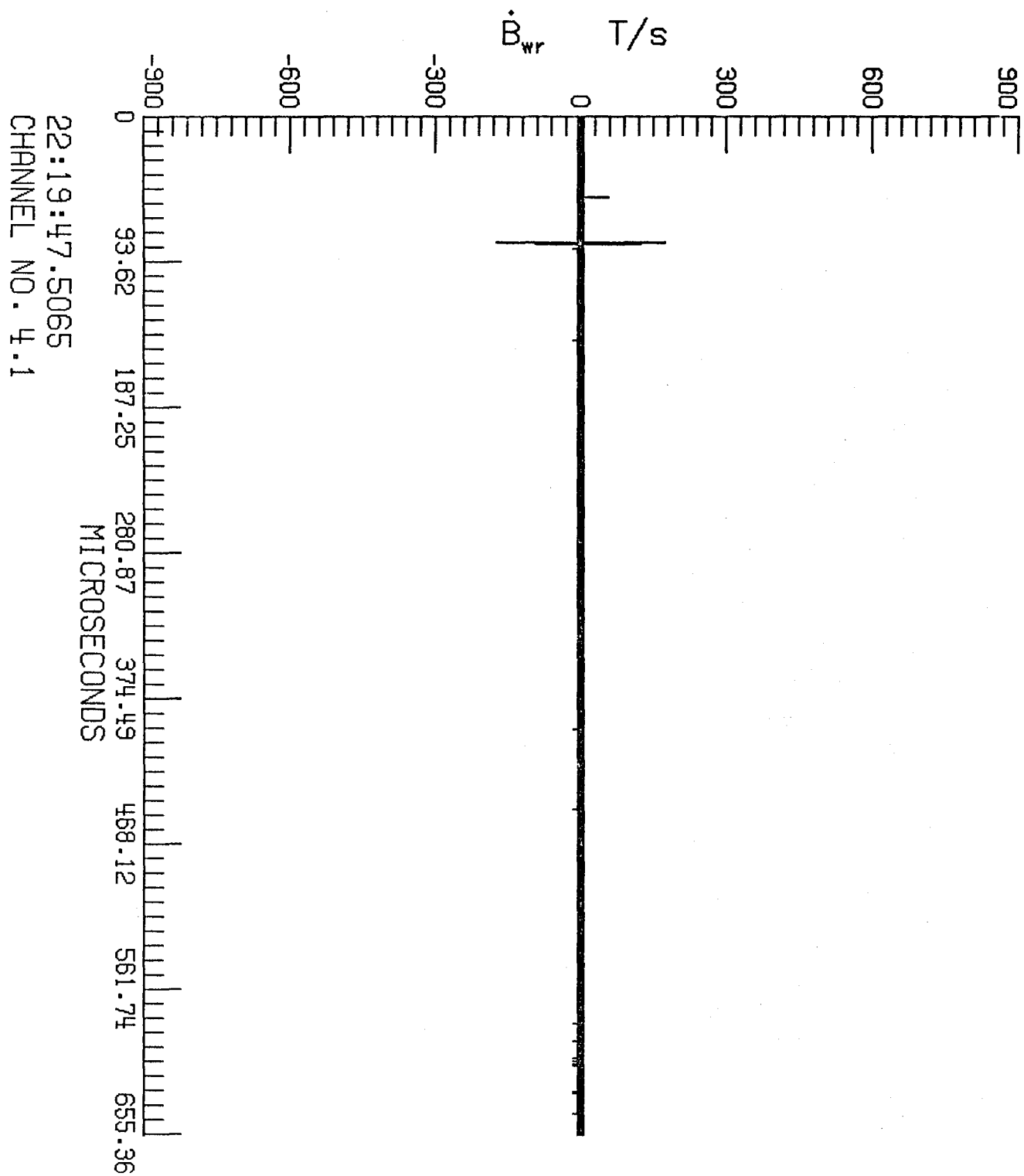


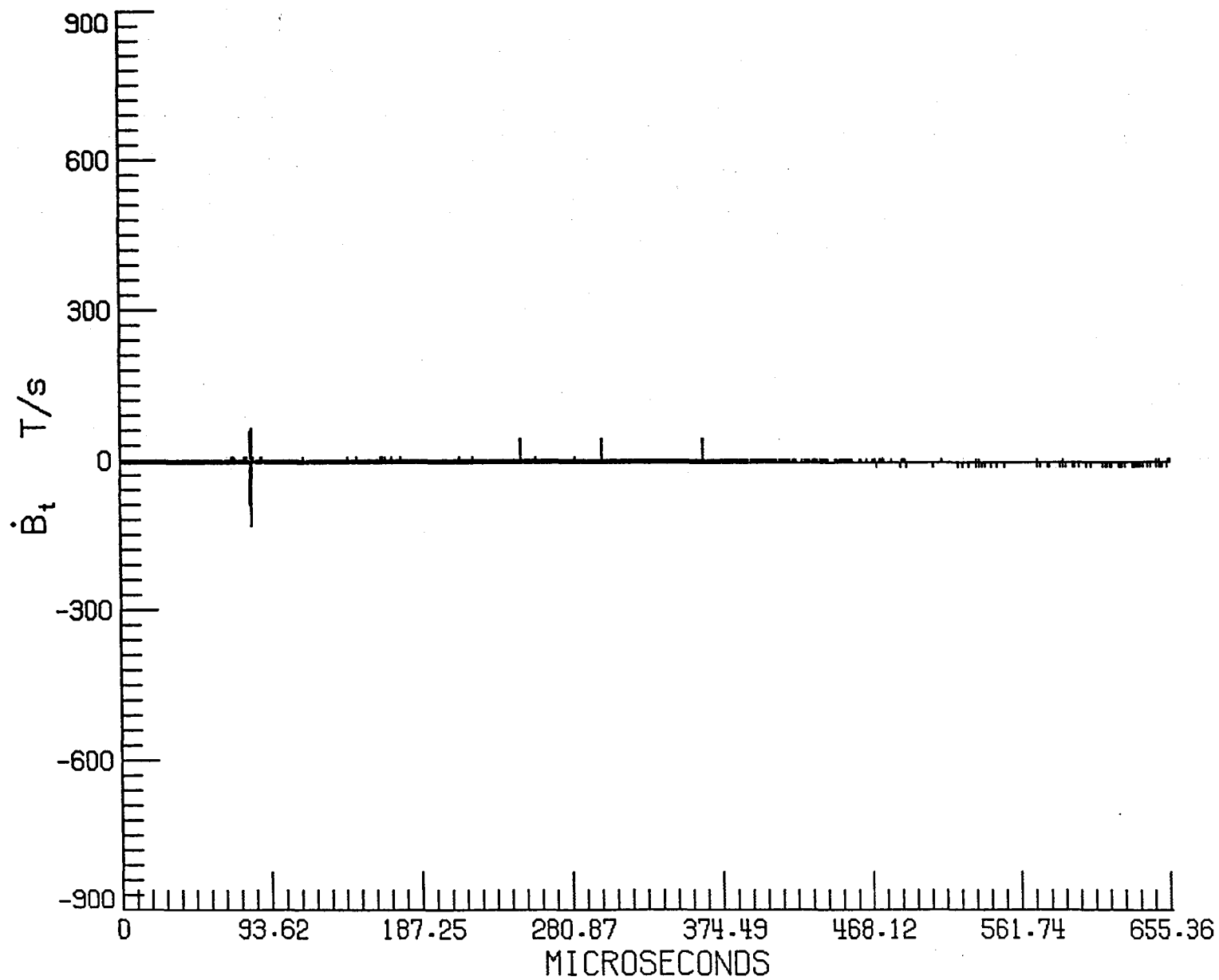




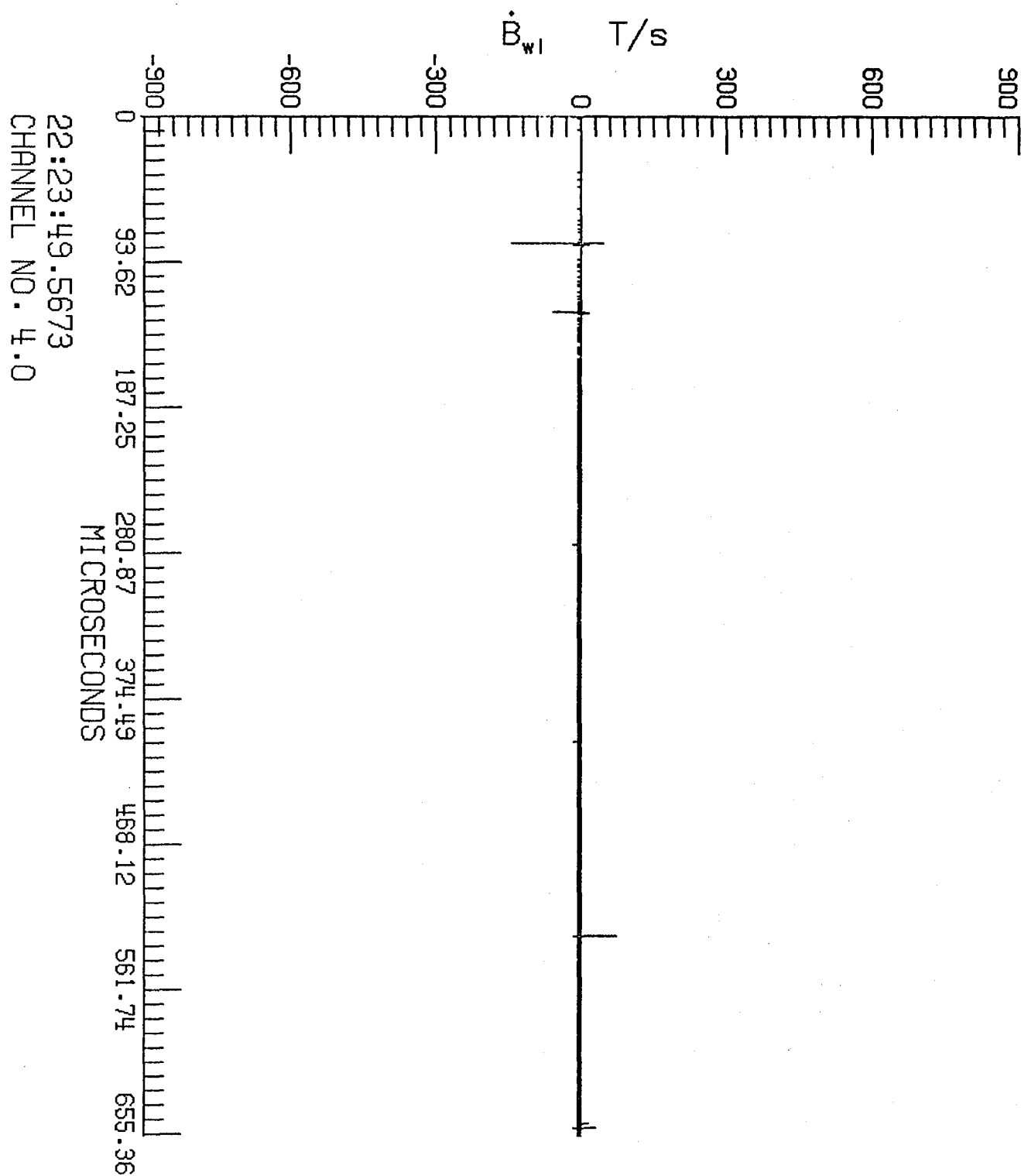
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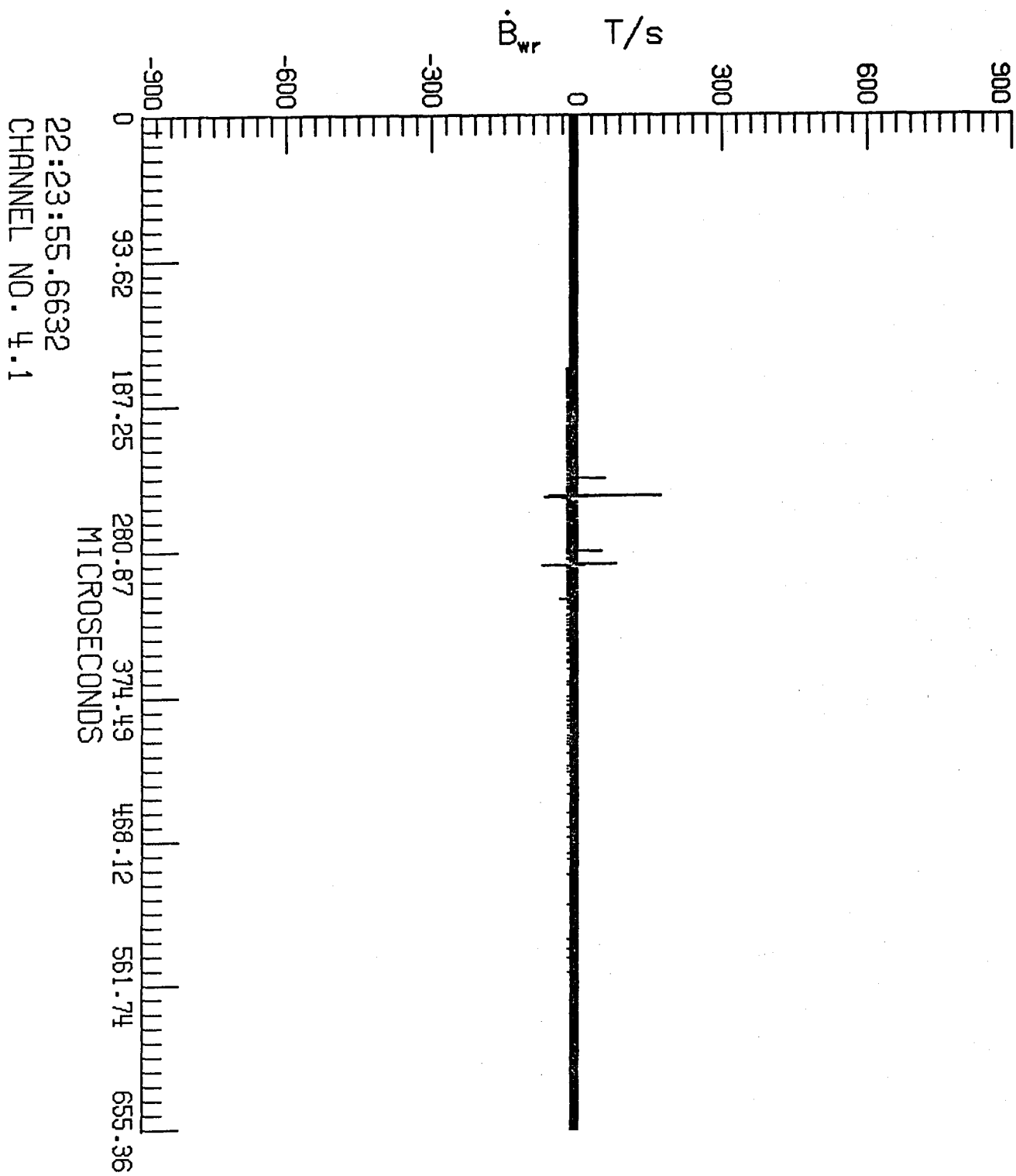
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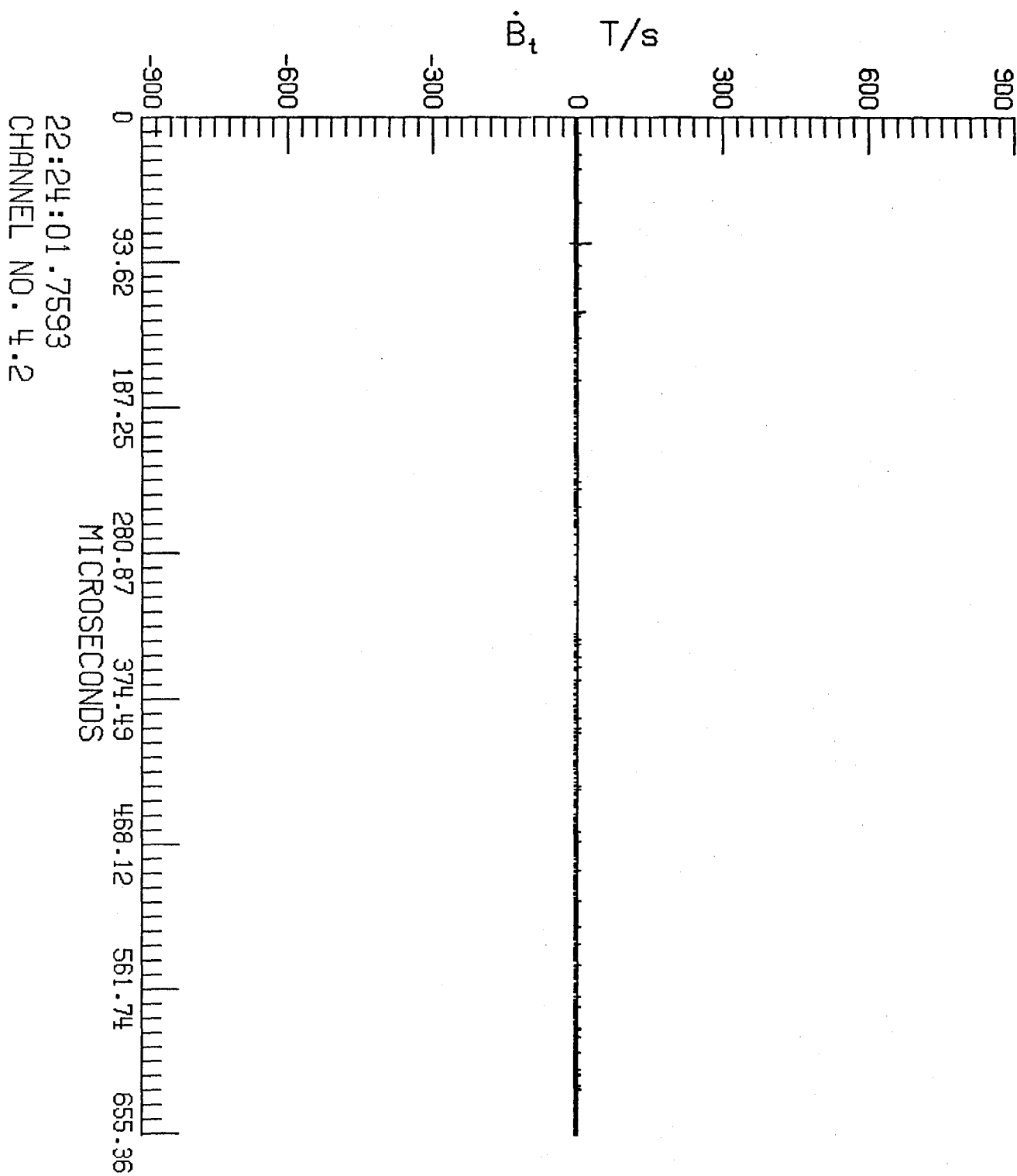


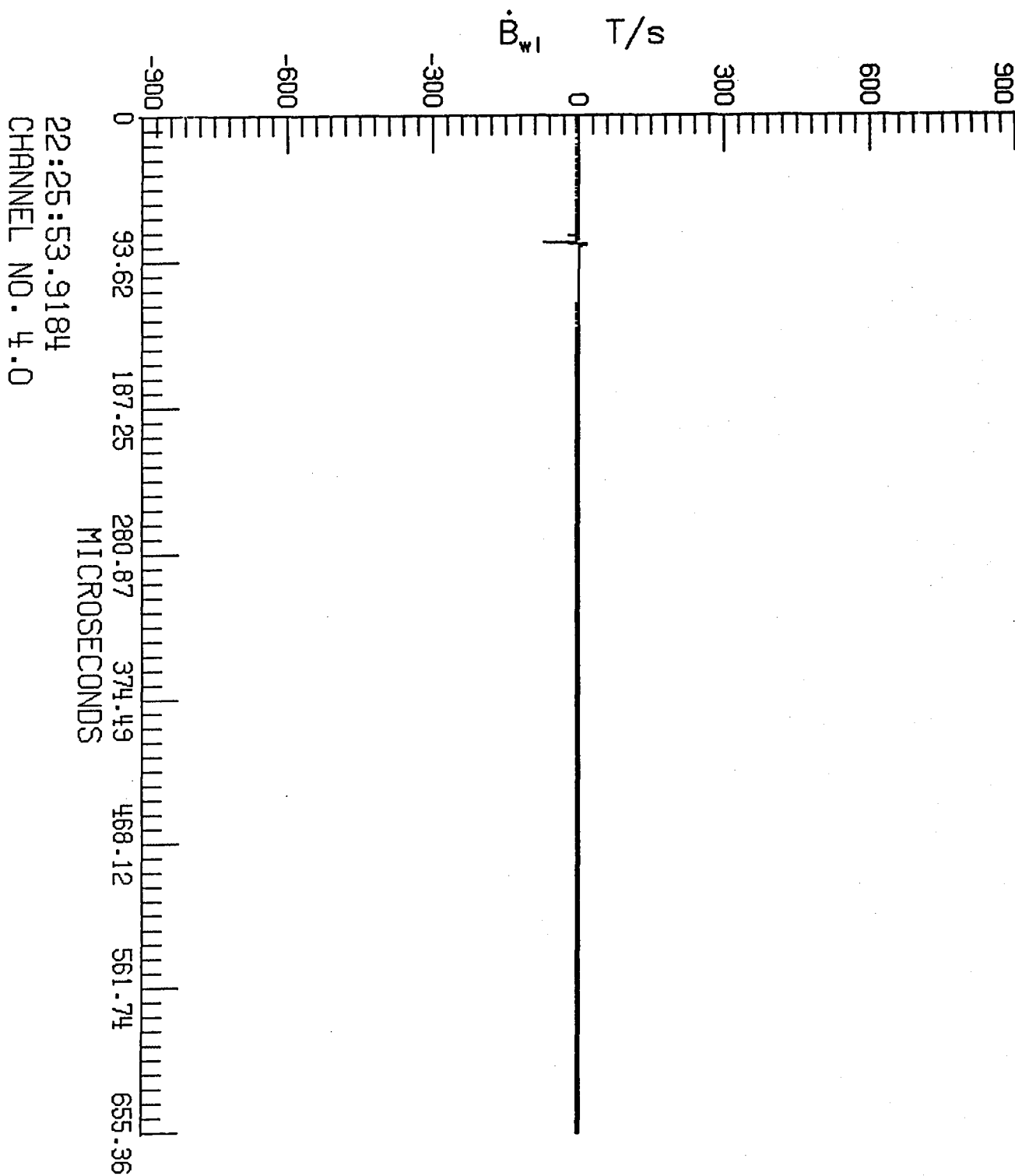


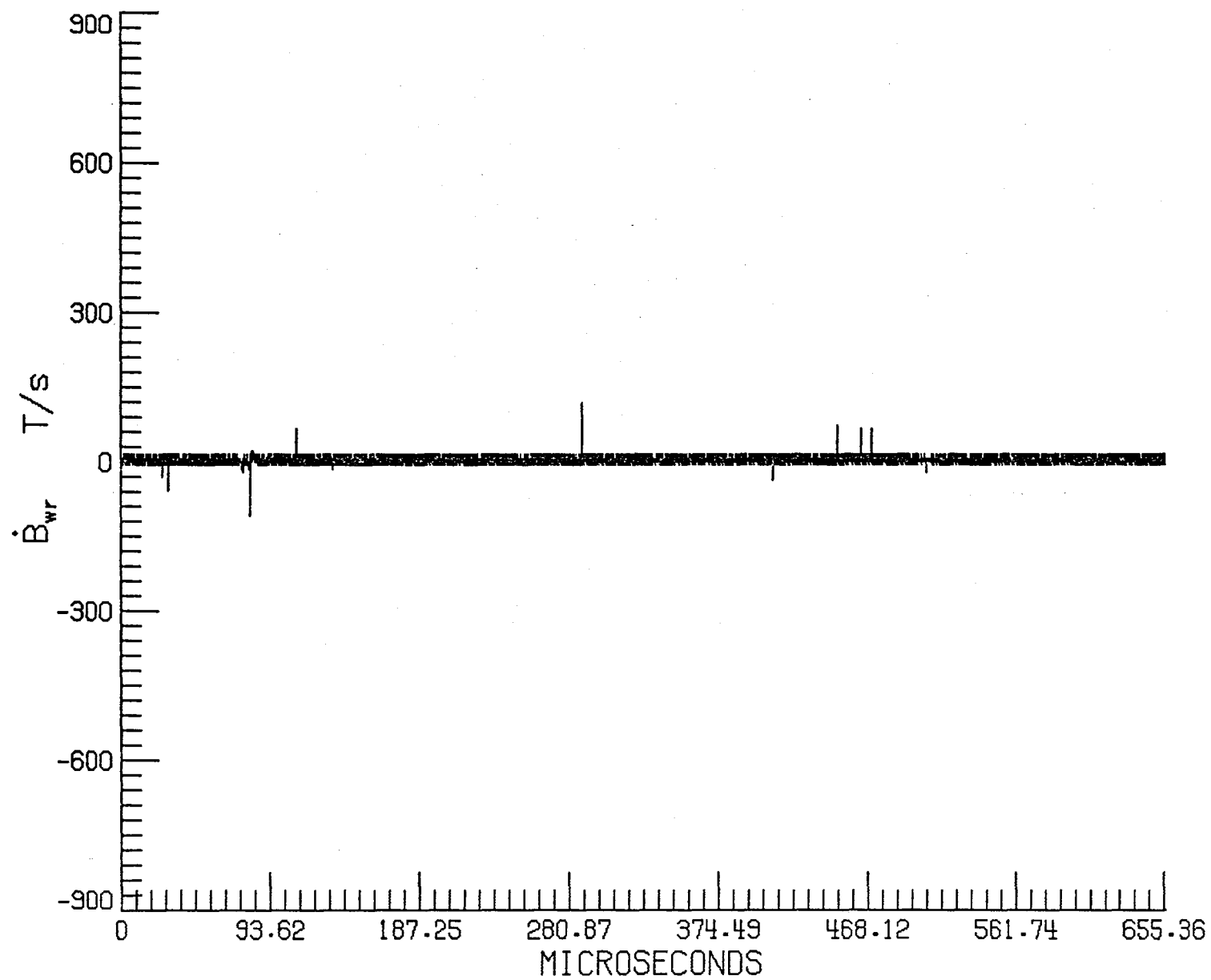
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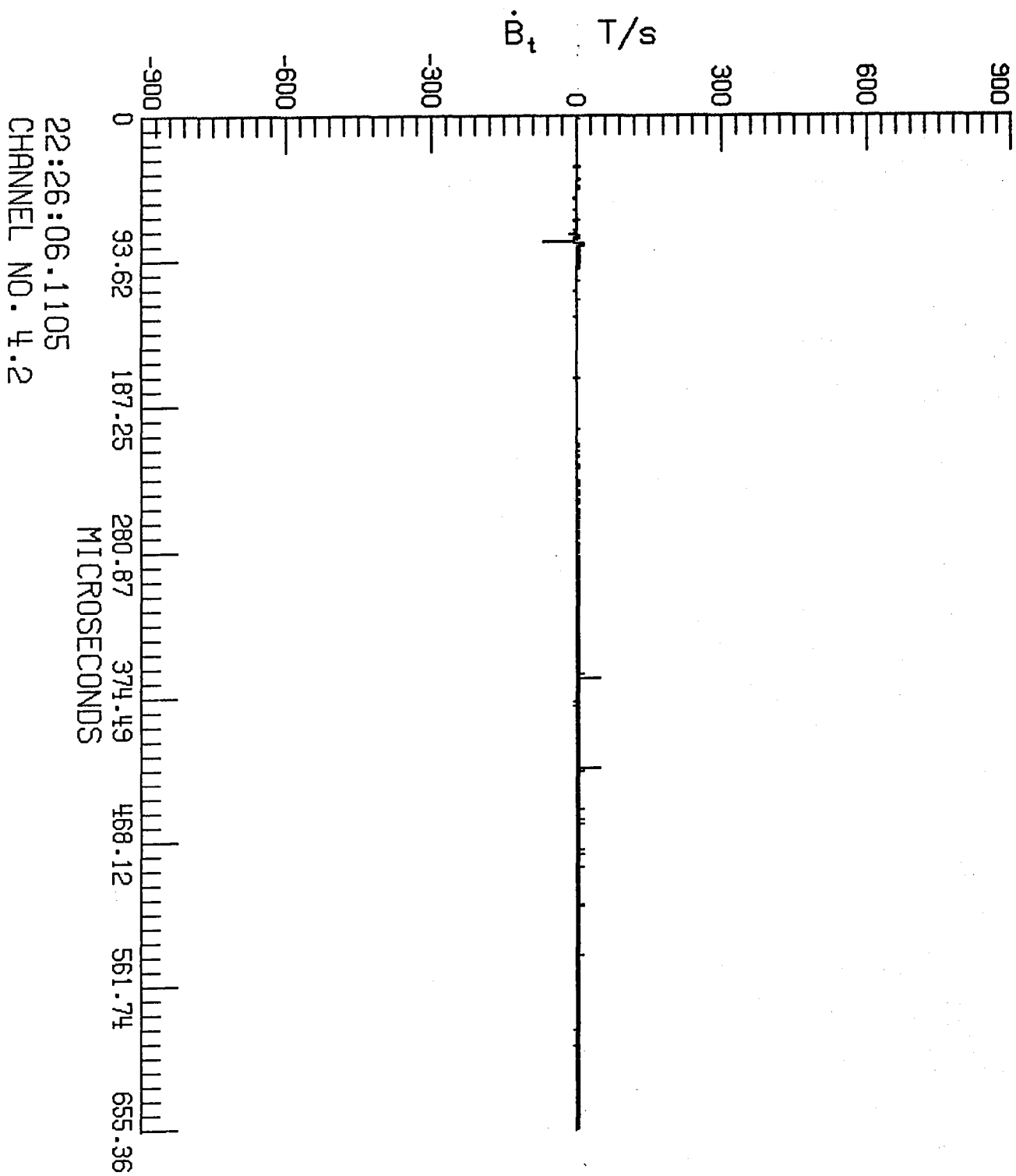


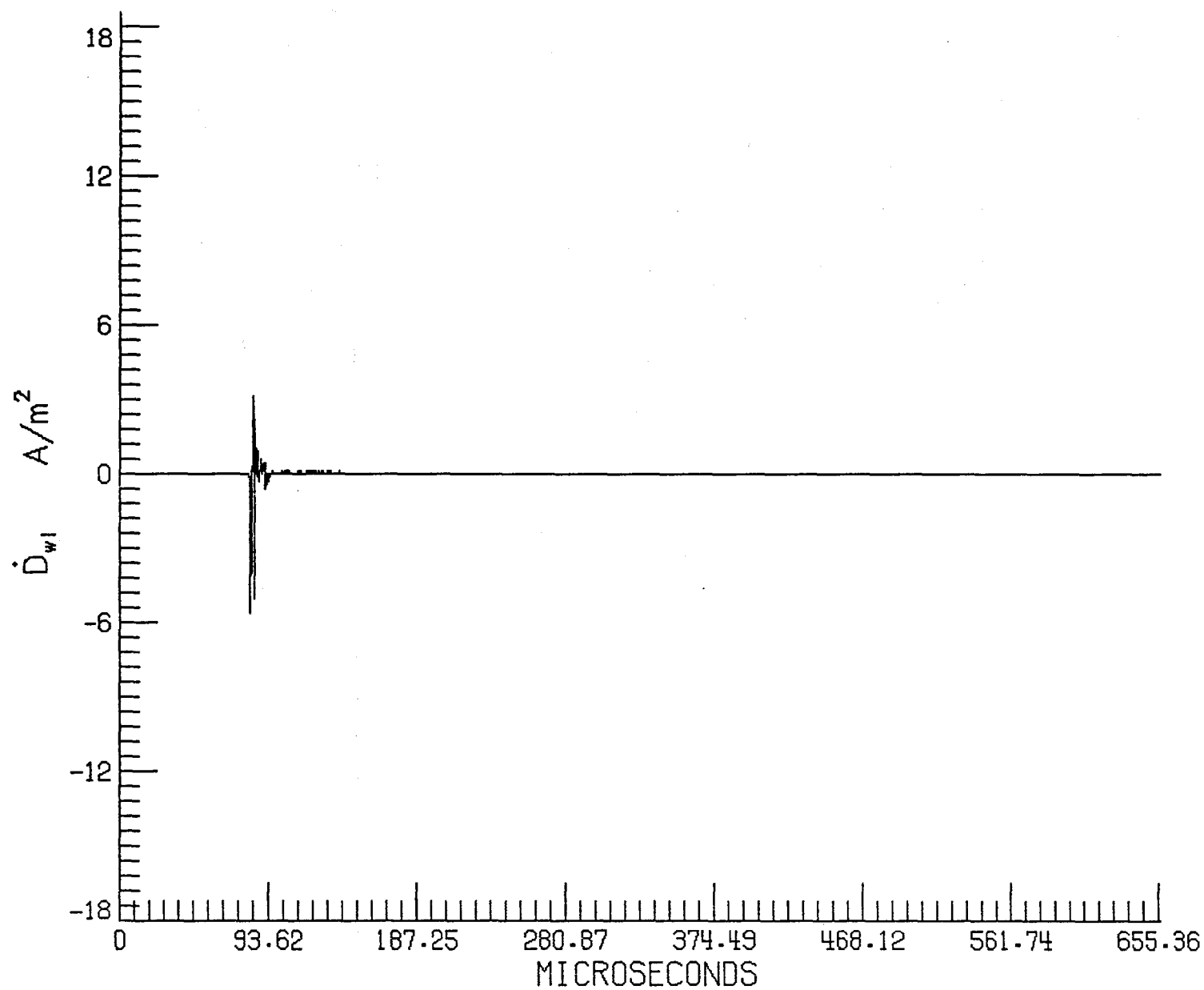




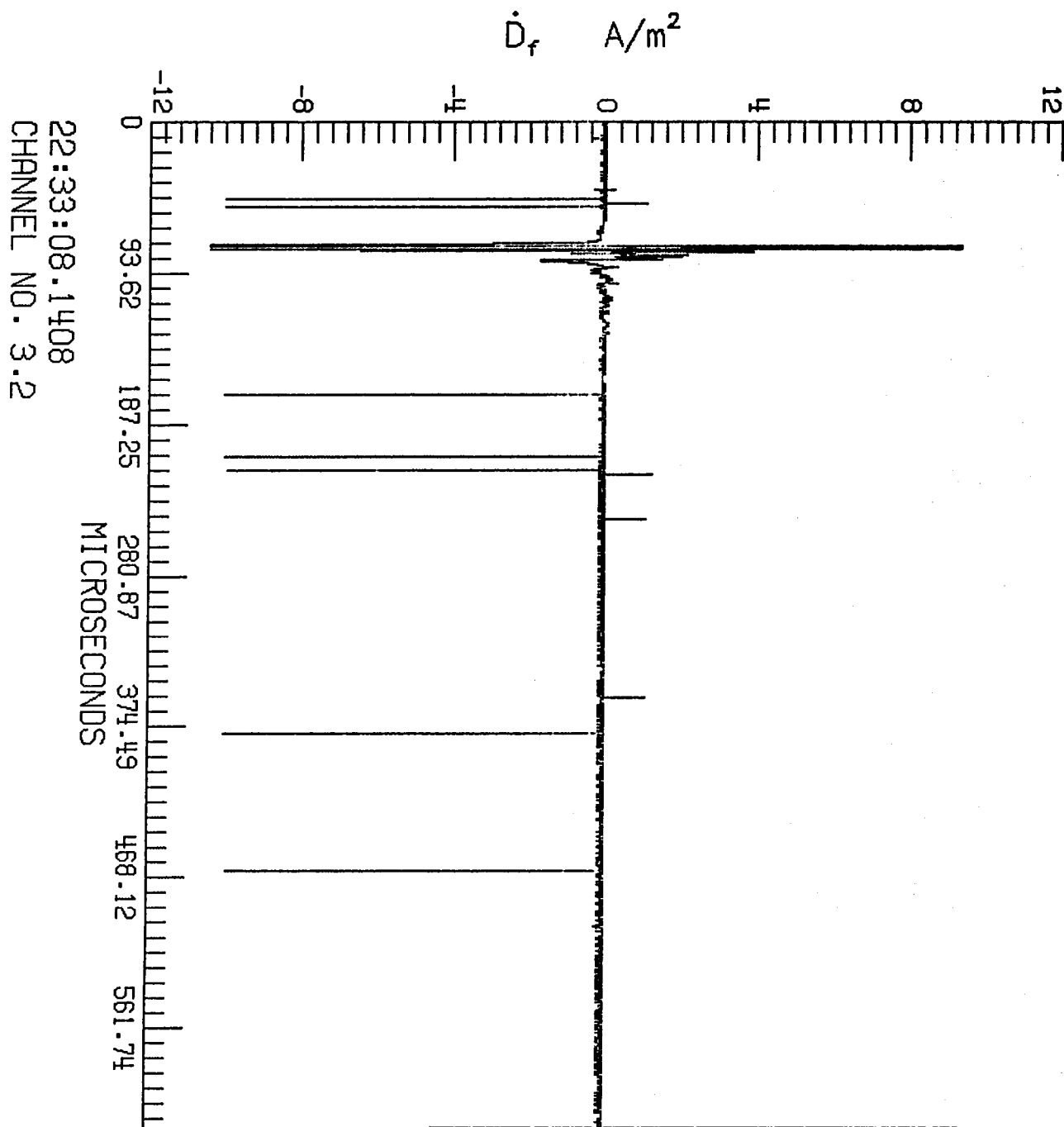


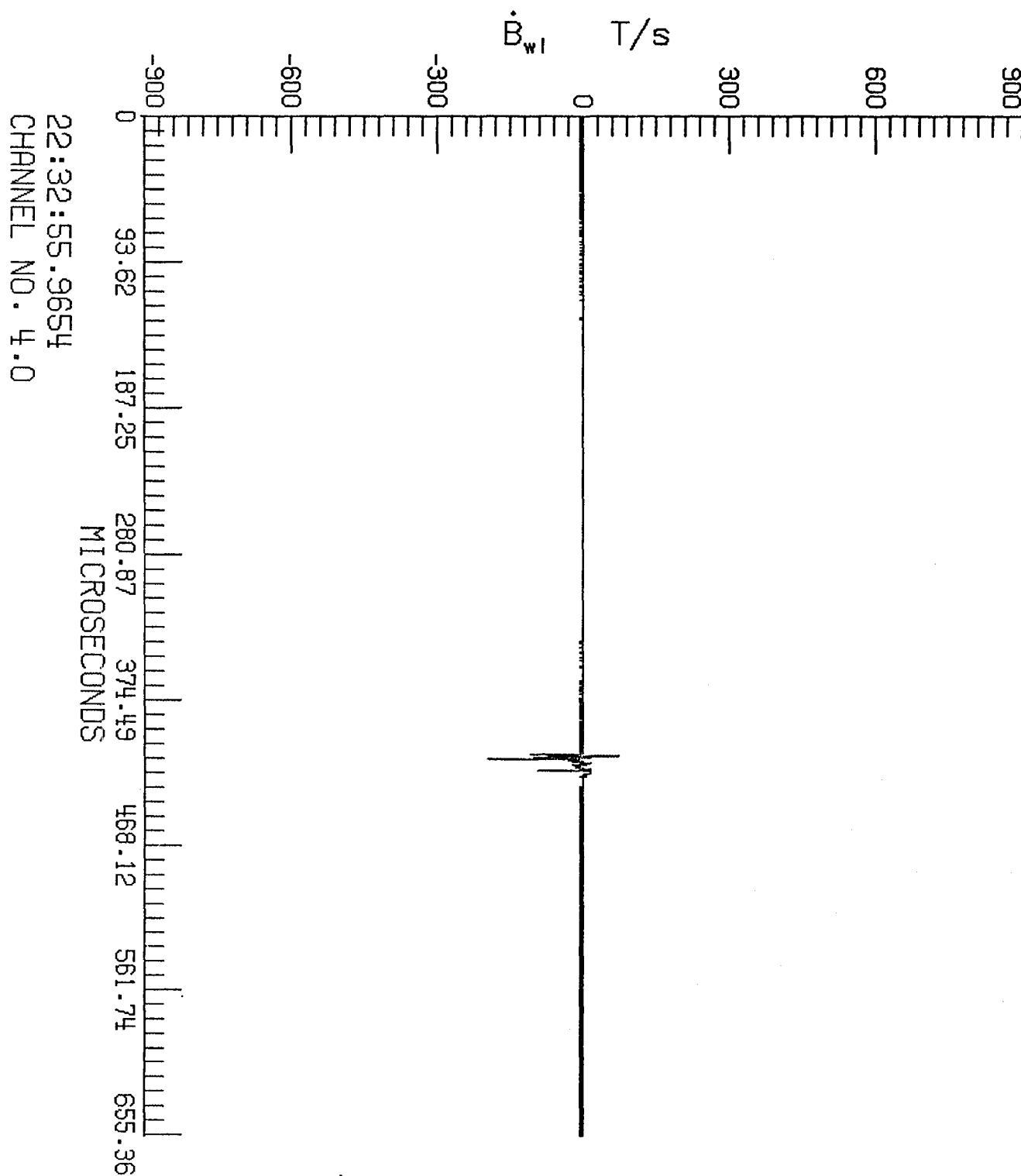
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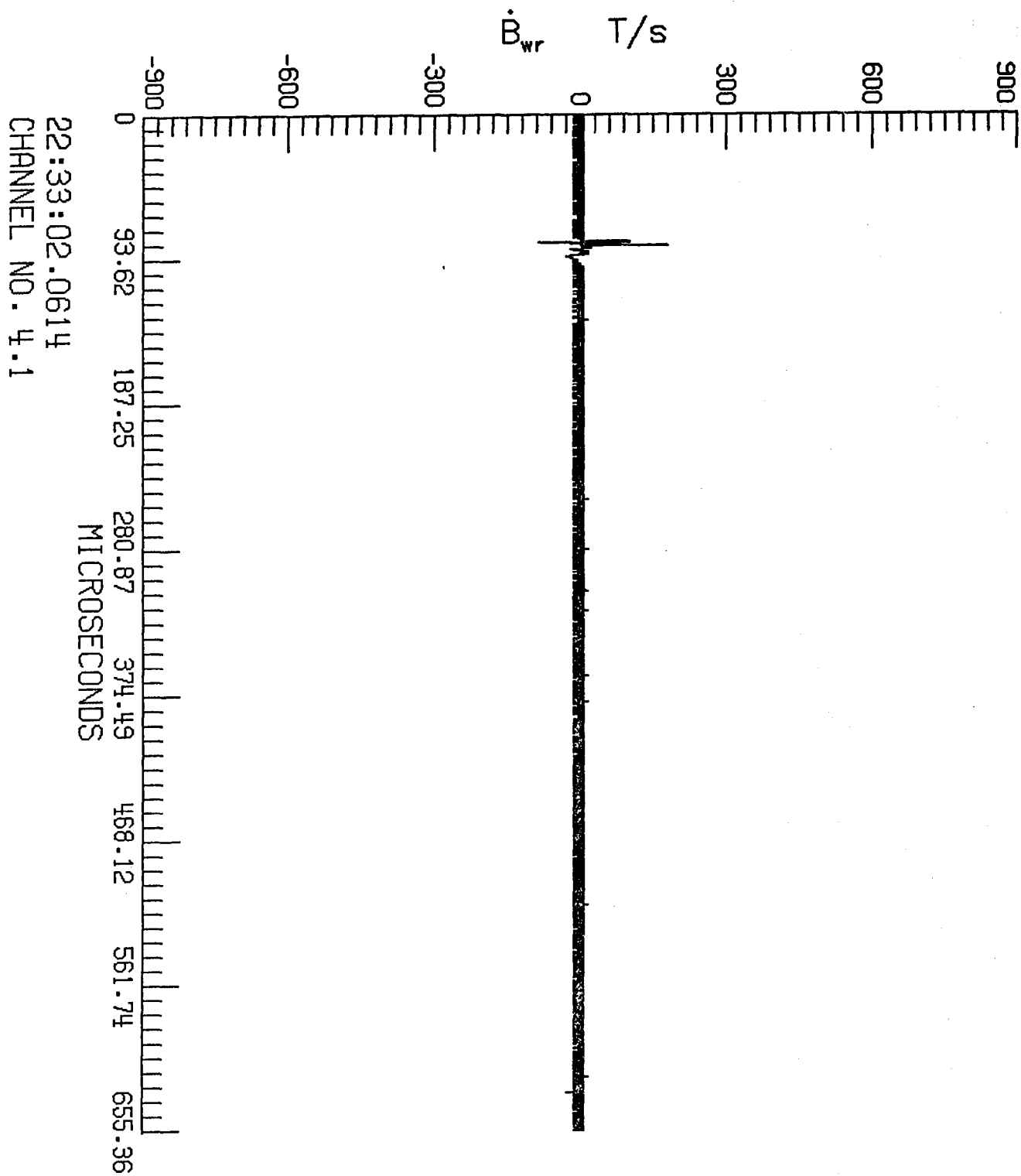


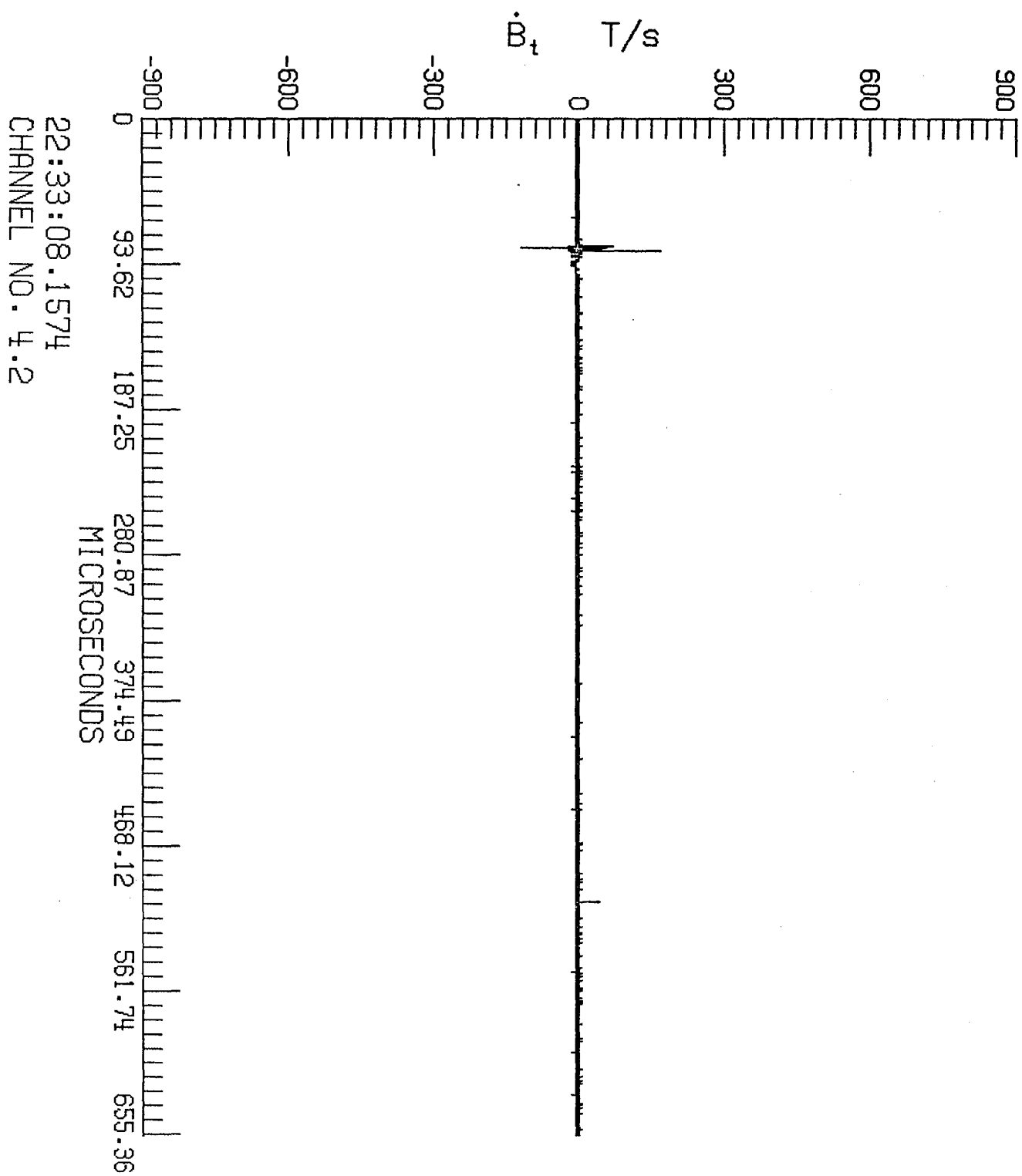


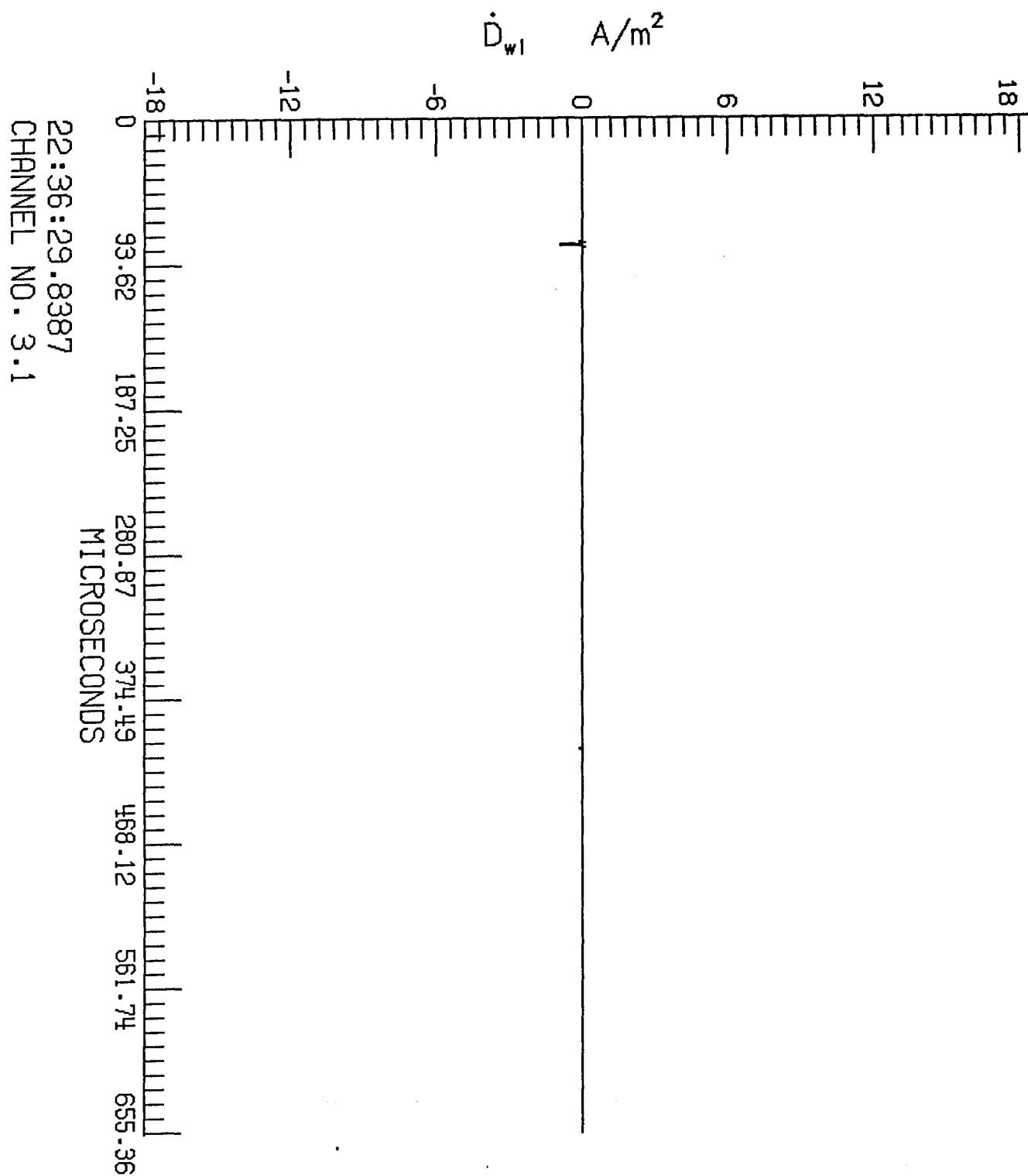
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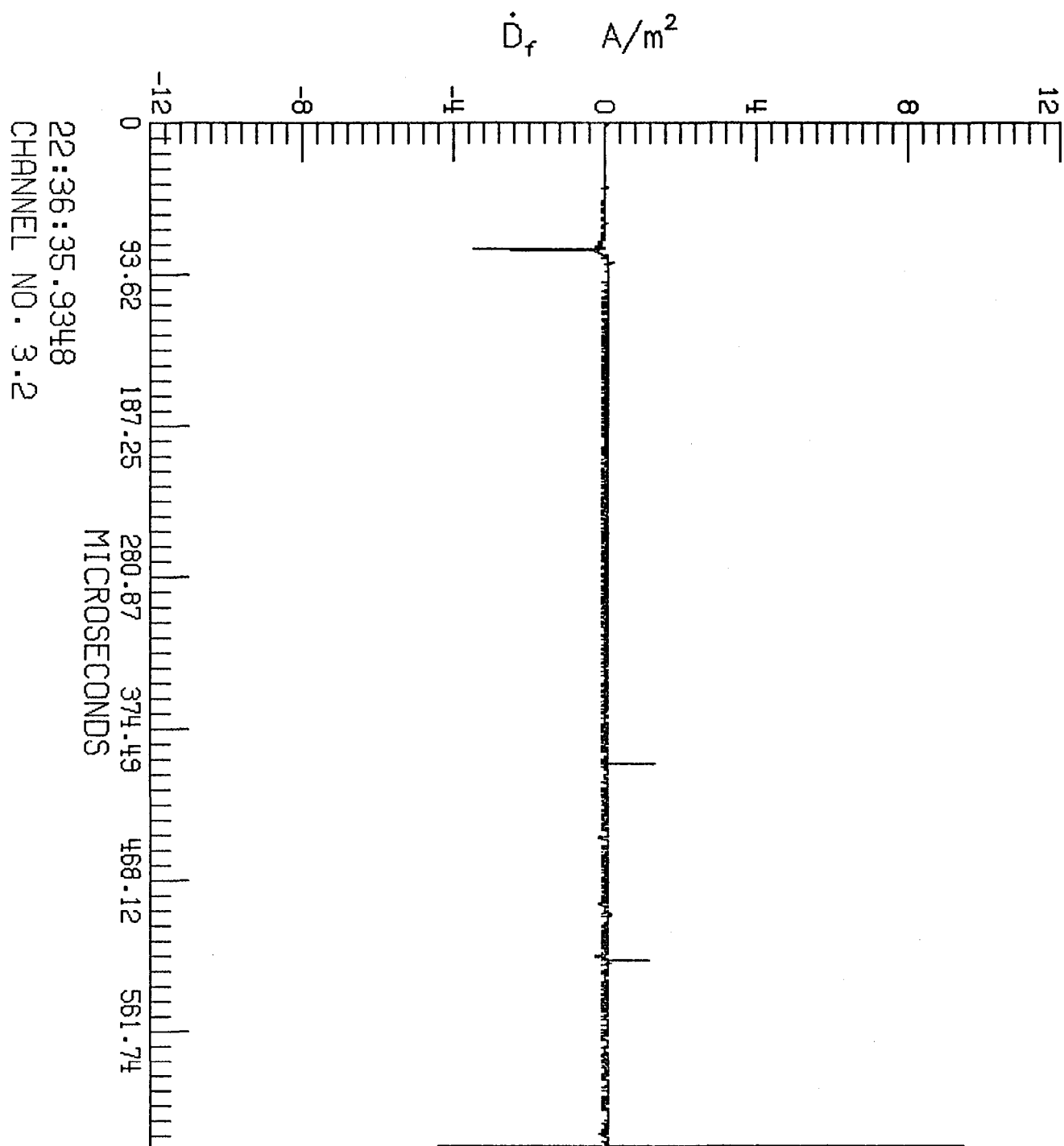


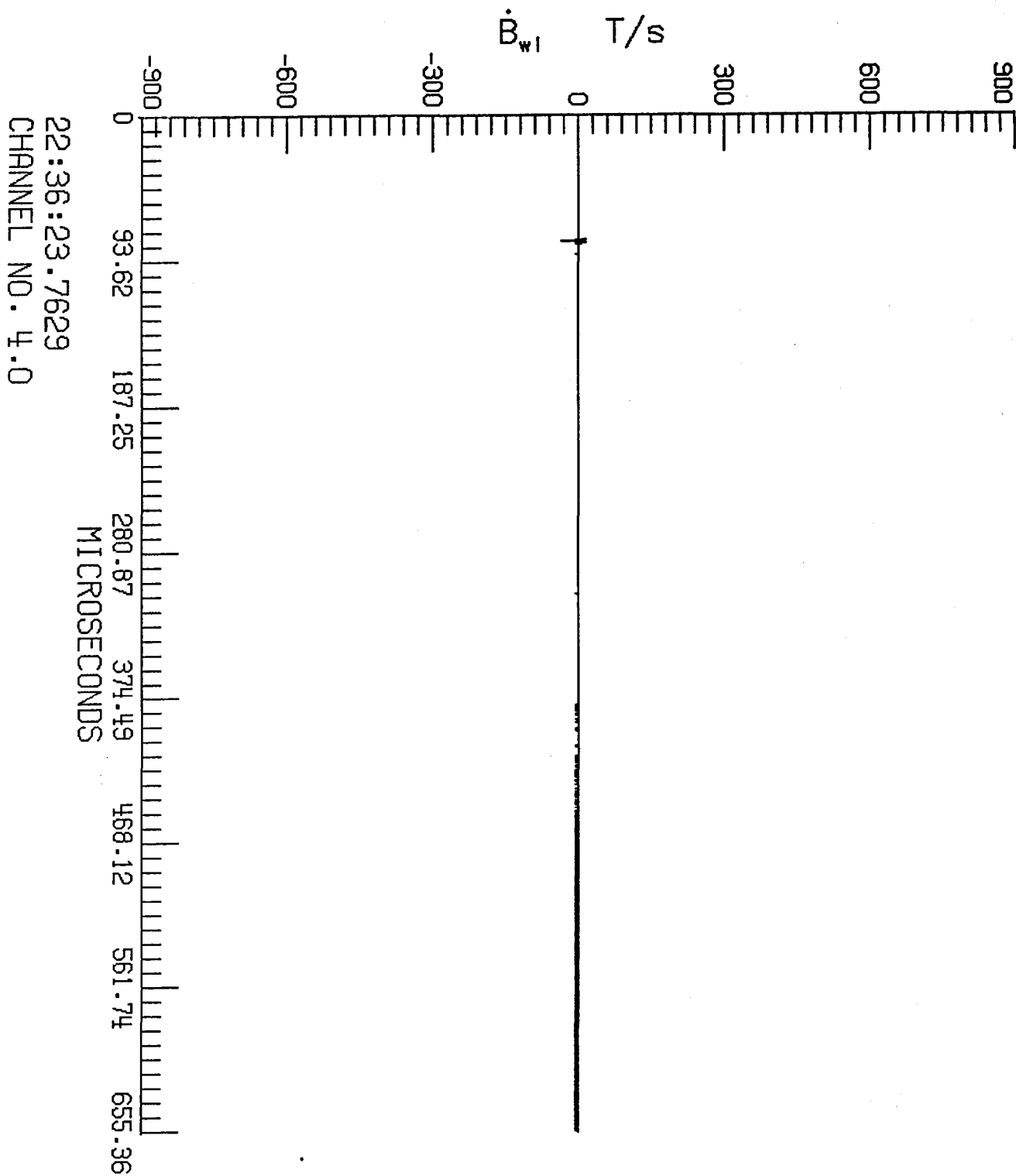




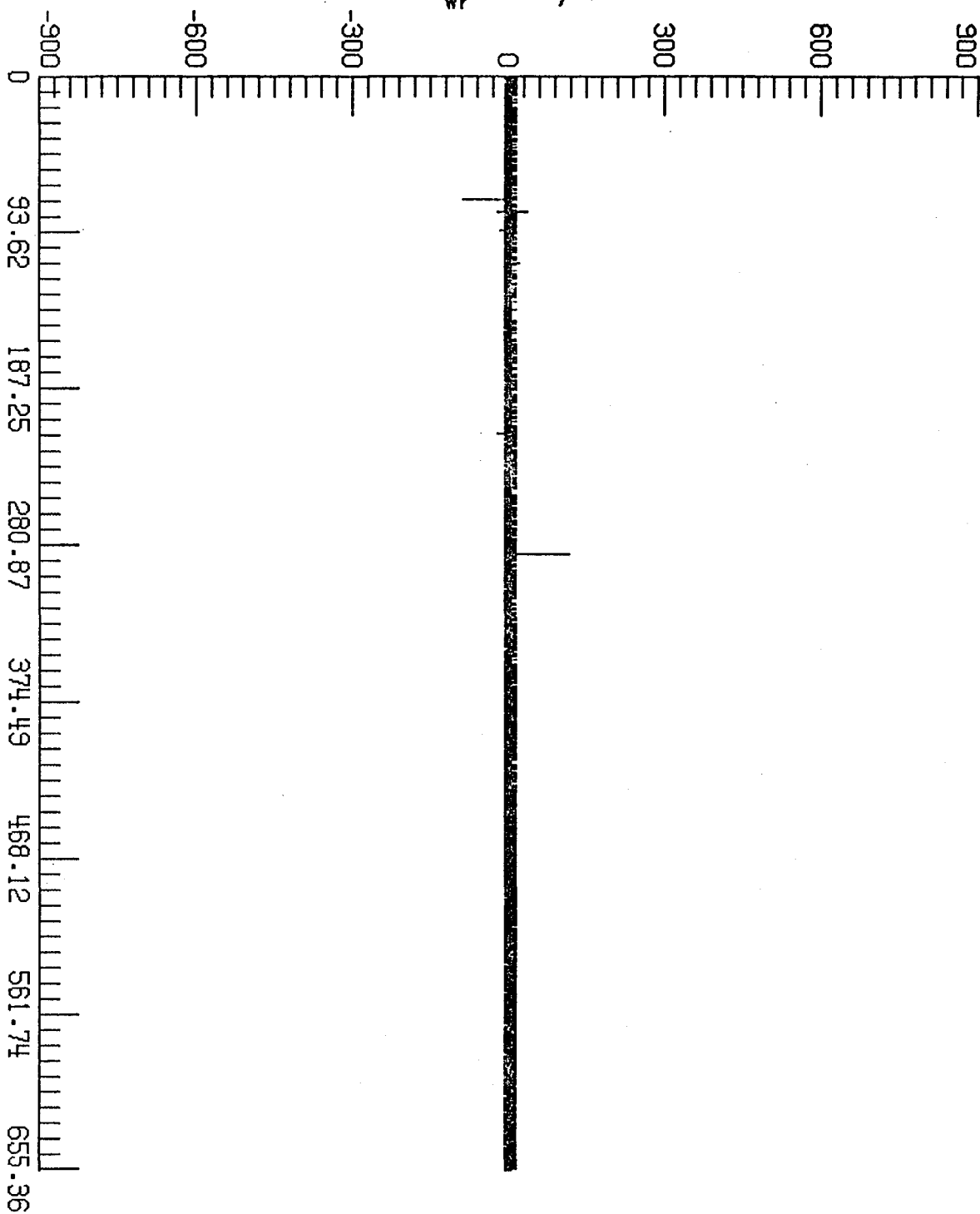




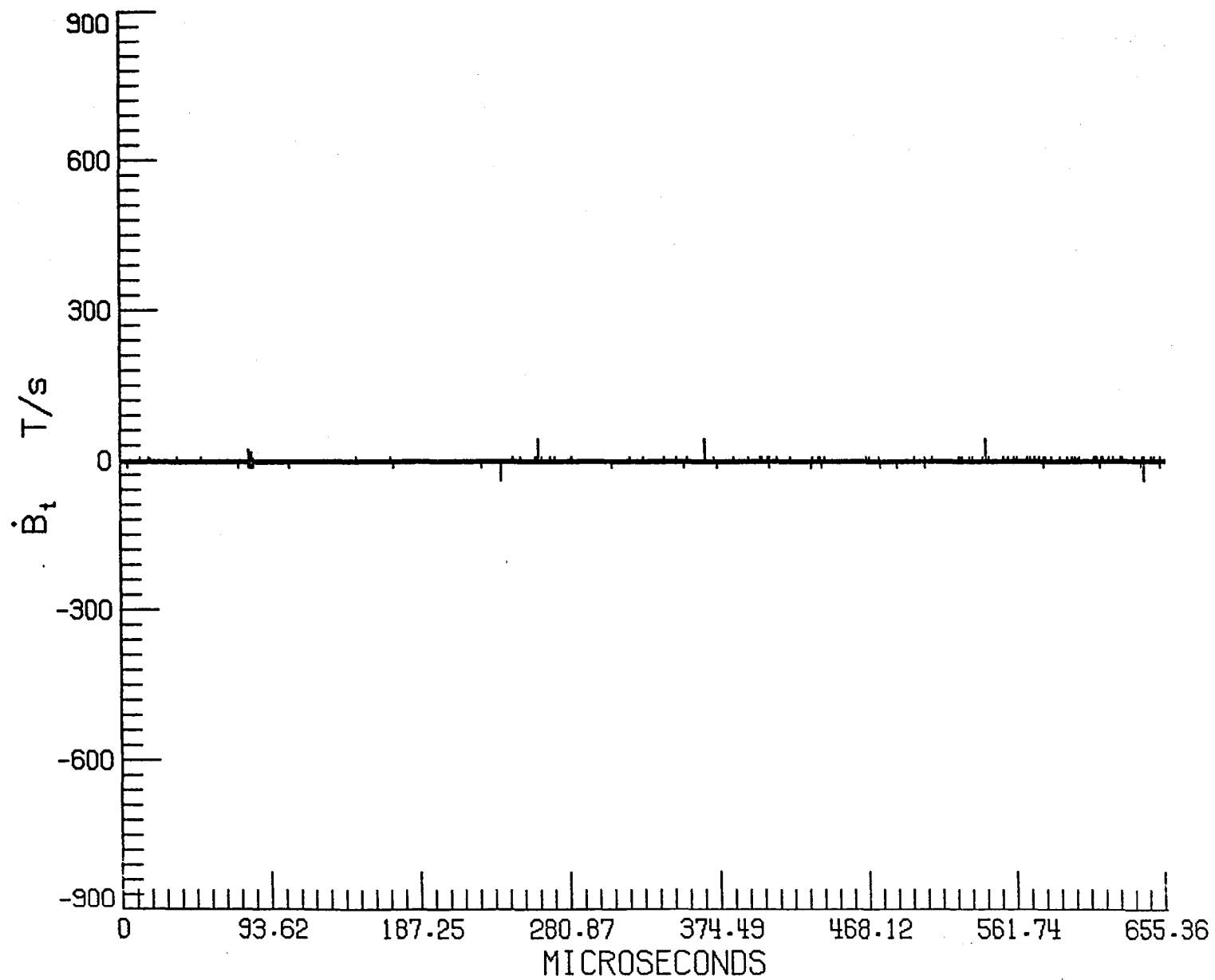




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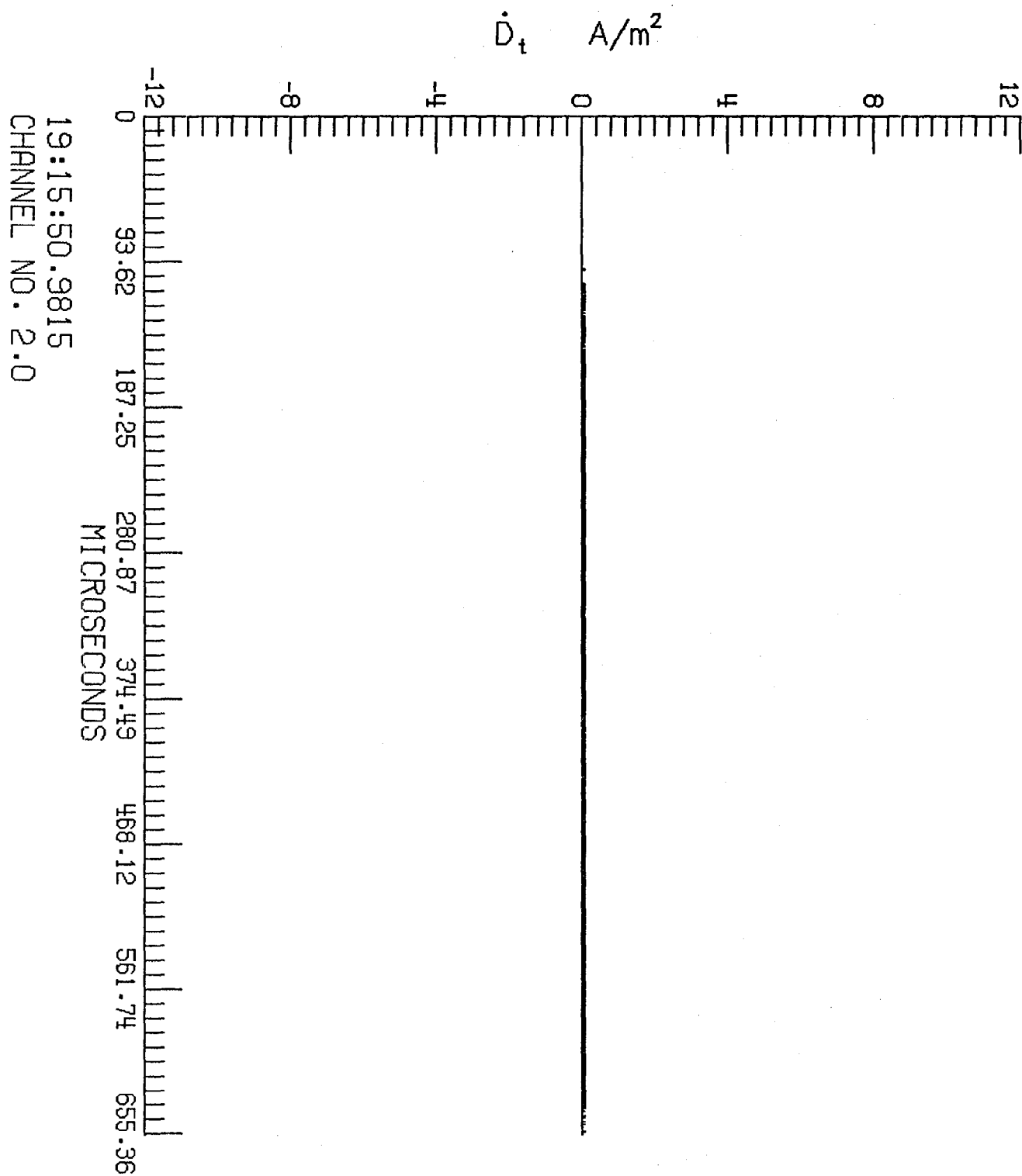


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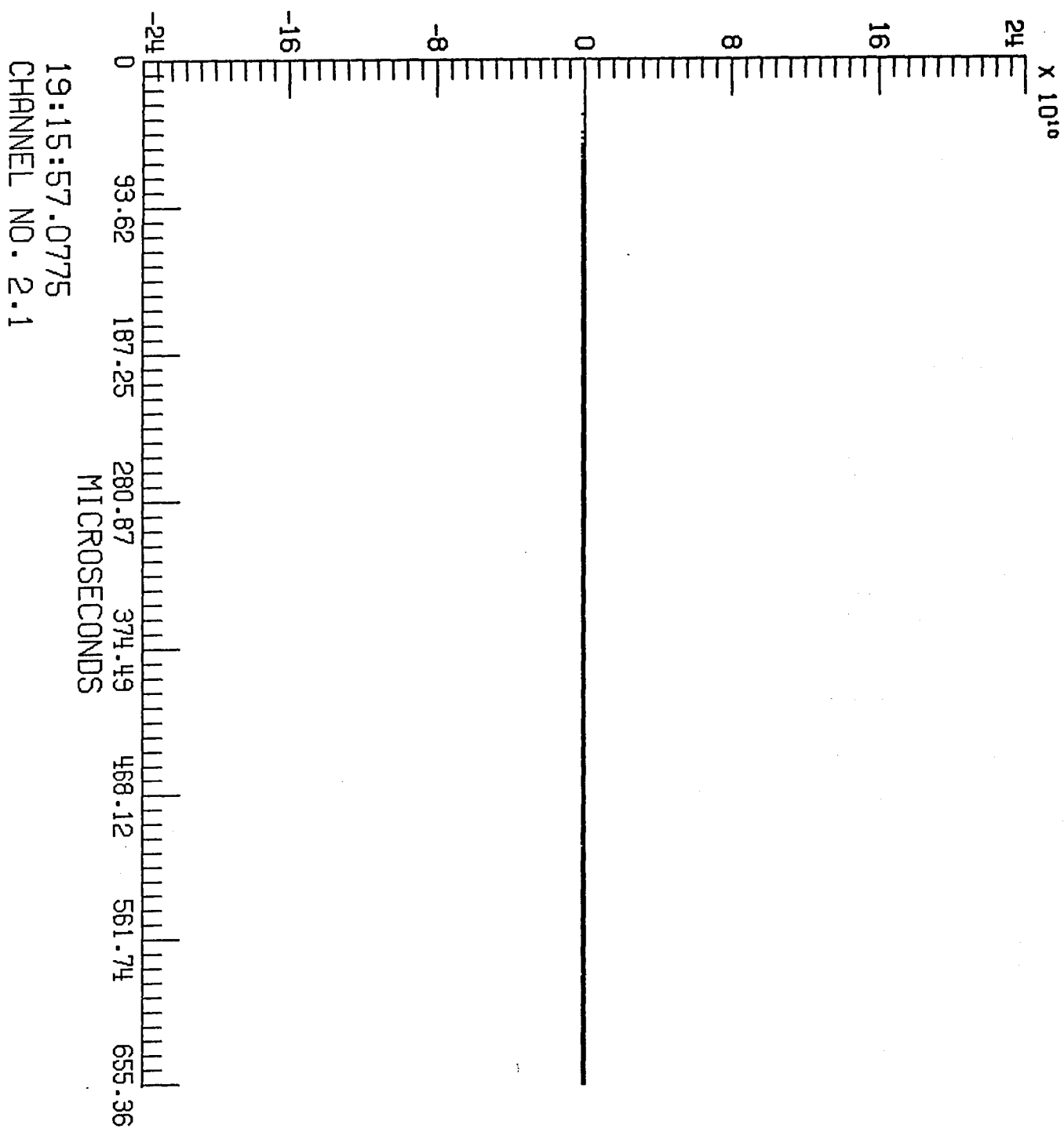


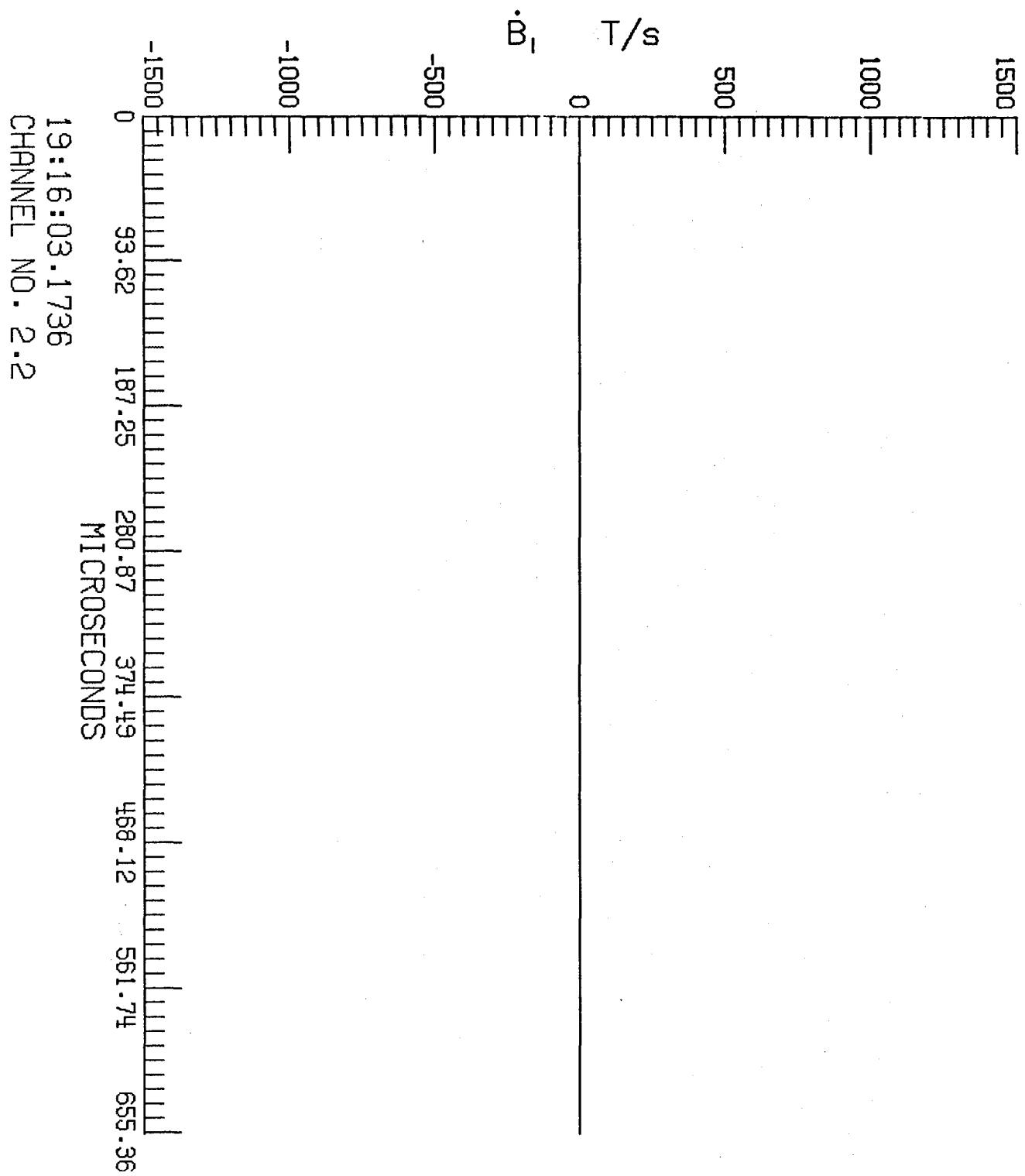
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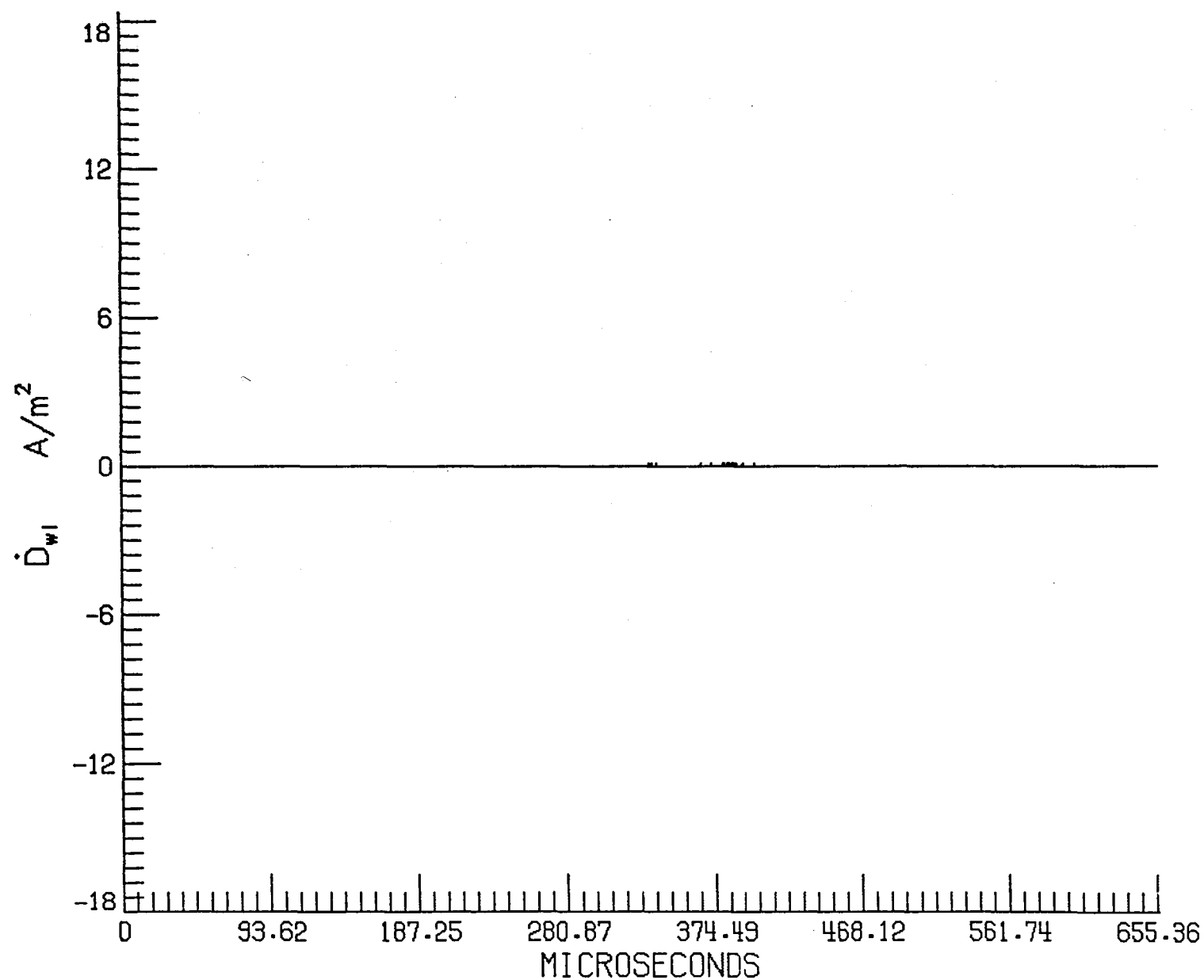
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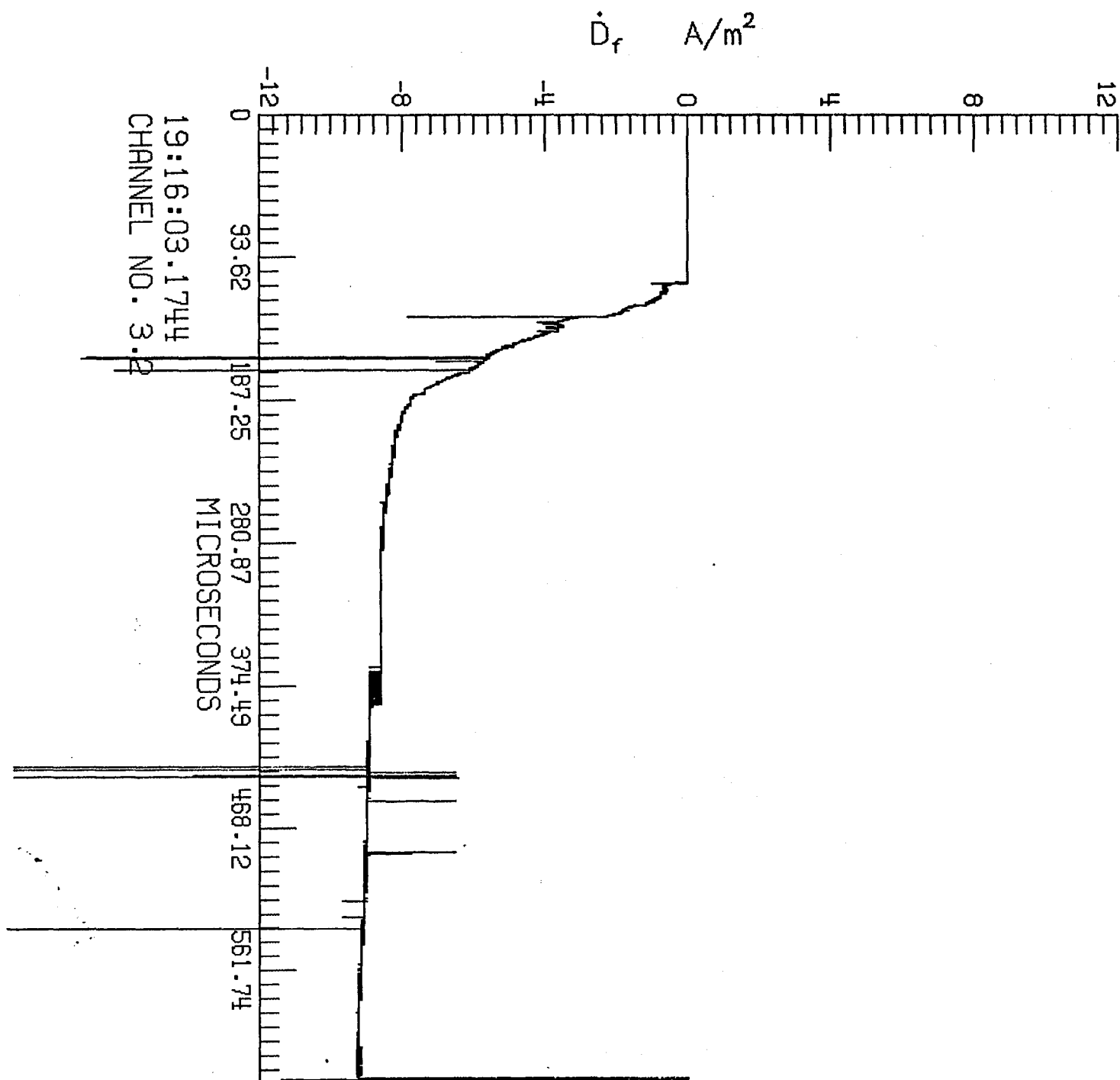
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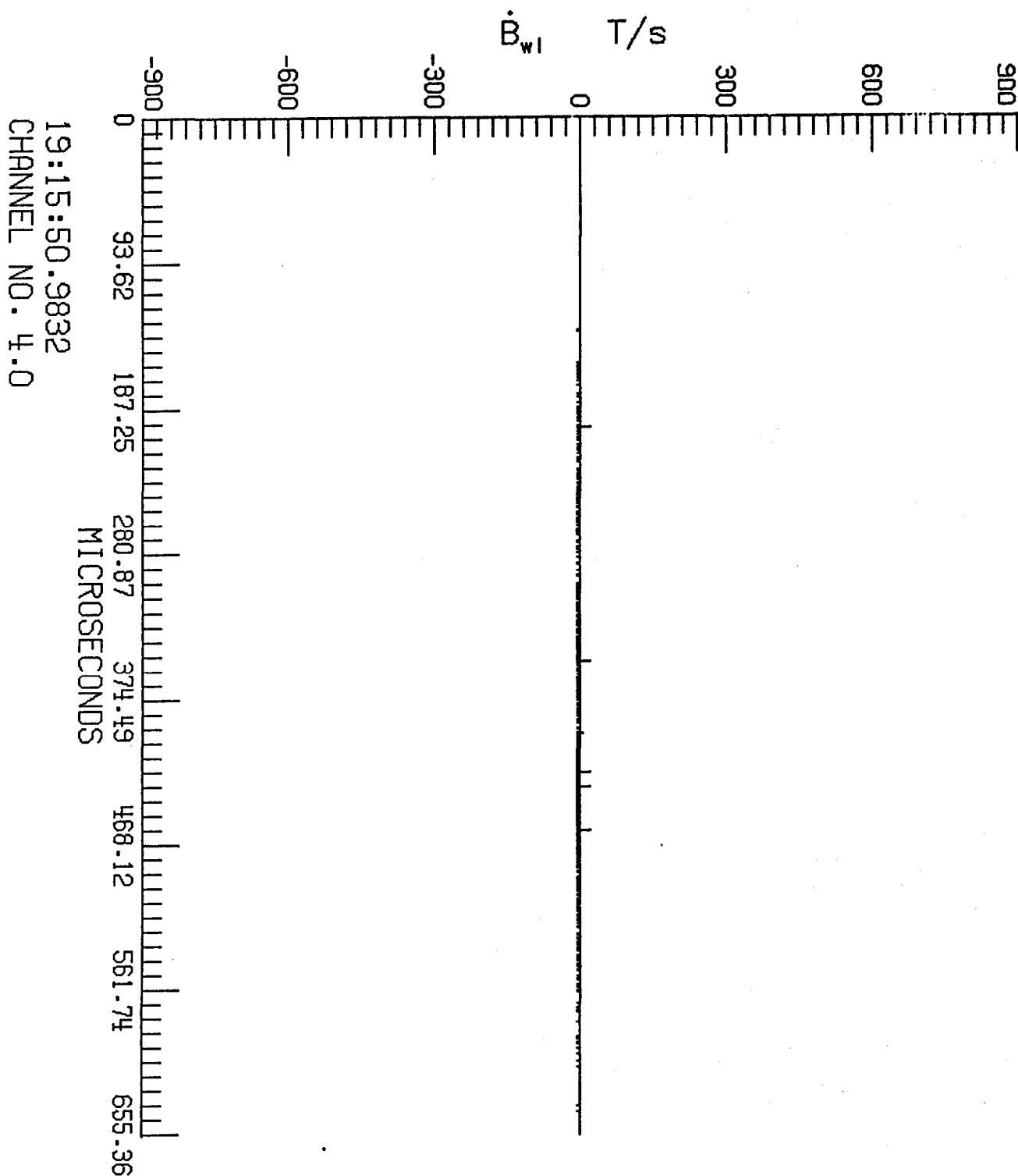


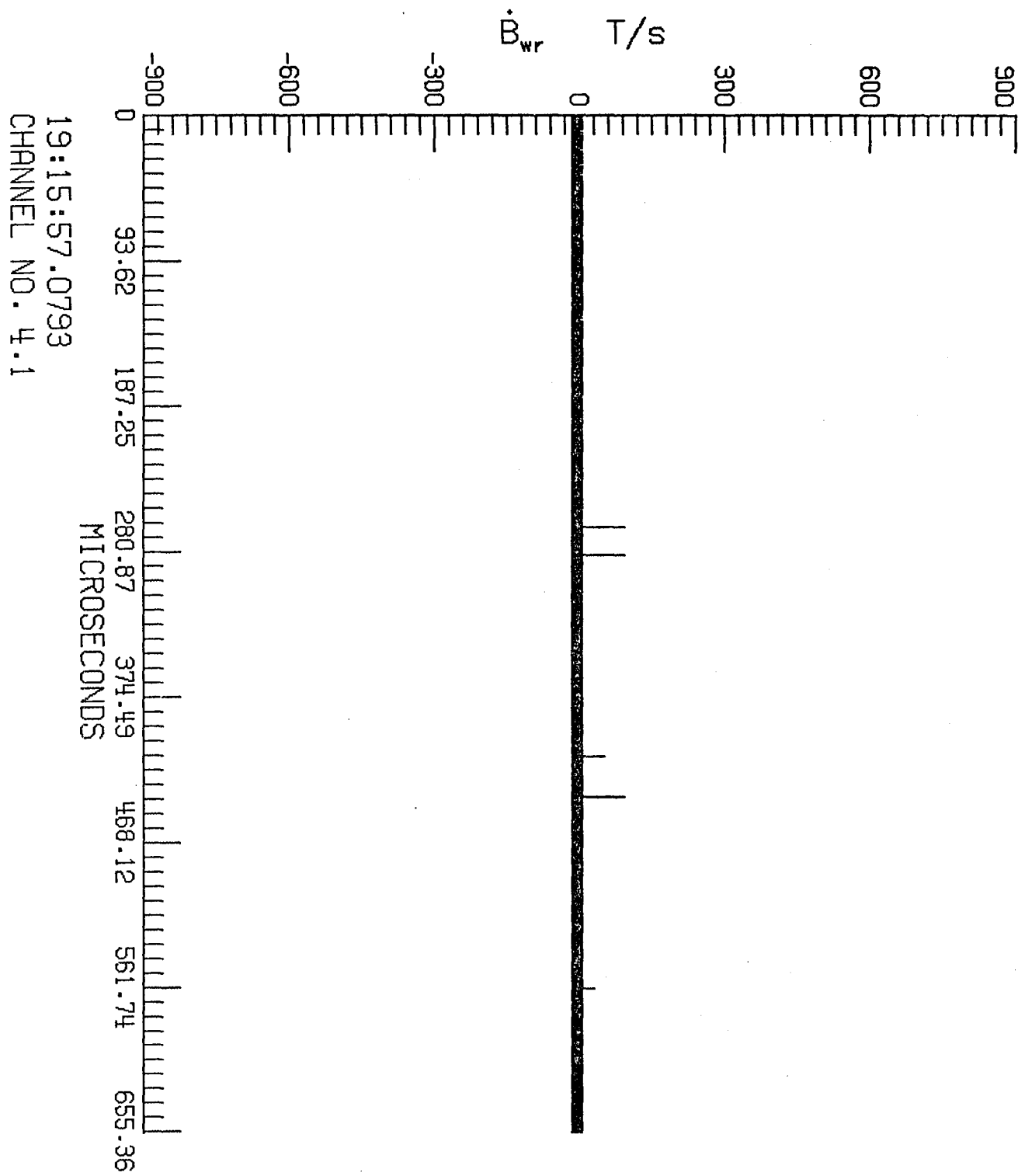


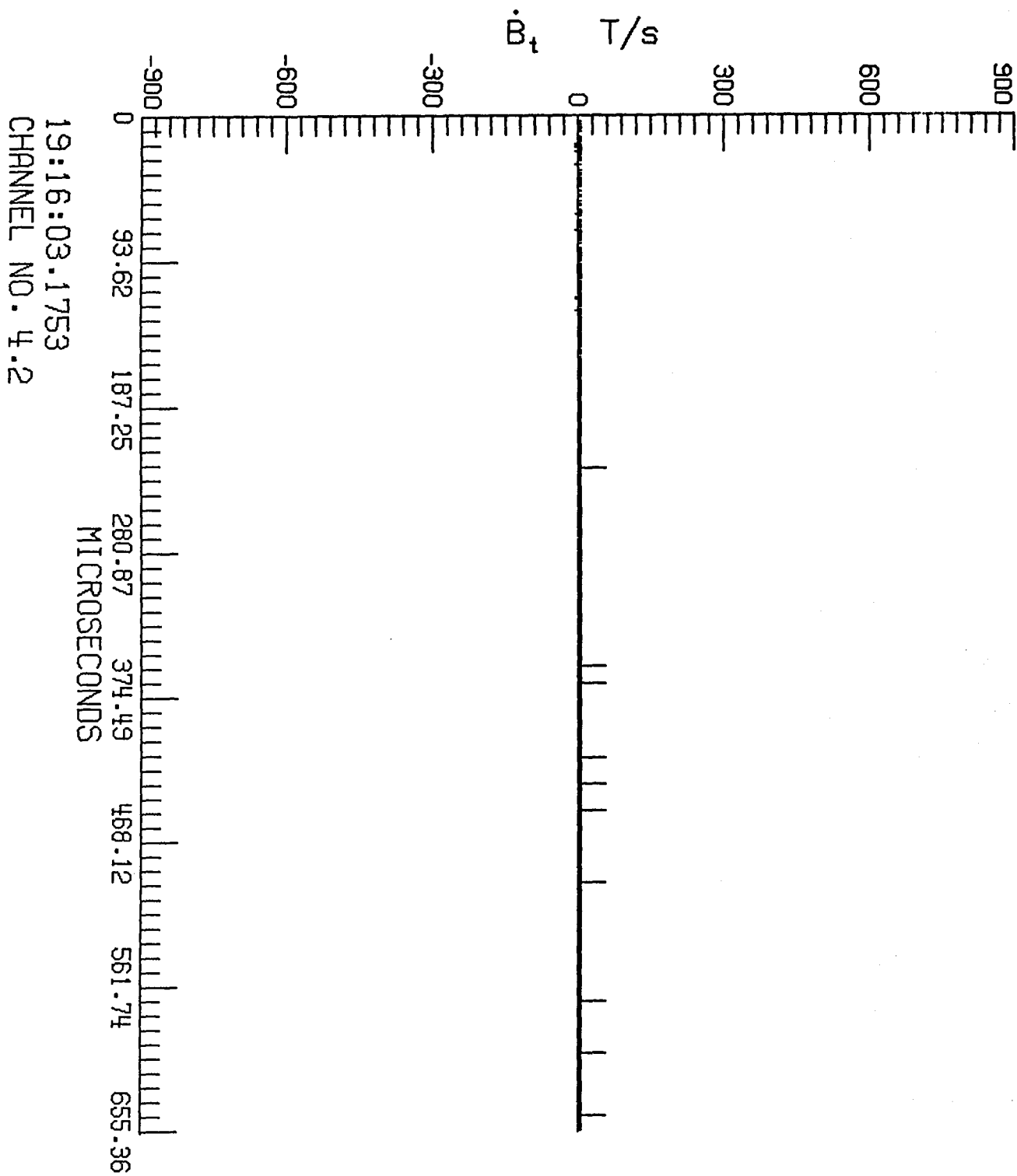


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CHANNEL NO. 3.1









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16. Abstract Data waveforms are presented which were obtained during the 1983 direct-strike lightning tests utilizing the NASA F106-B aircraft specially instrumented for lightning electromagnetic measurements. The aircraft was operated in the vicinity of the NASA Langley Research Center, Hampton, Virginia, in a thunderstorm environment to elicit strikes. Electromagnetic field data and conduction currents on the aircraft were recorded for attached lightning.					
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